Healthcare Spending and Utilization of Lung Cancer Patients Using 2002-2012 Health Insurance Claims Data

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Humble yourselves, therefore, under the mighty hand of God so that at the proper time he may exalt you, casting all your anxieties on him, because he cares for you.
And after you have suffered for a little, the God of all grace, who called you to His eternal glory in Christ, will Himself perfect, confirm, strengthen, and establish you.

1 Peter 5:6-7,10

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ABSTRACT

Healthcare Spending and Utilization of Lung Cancer Patients Using 2002-2012 Health Insurance Claims Data

Background: Over the past decades, lung cancer has one of the highest fatality rates, and is the leading cause of cancer-related mortality and disease burden not only in South Korea but also worldwide. Studies focused on lung cancer are well documented, however, the factors that are associated with survival probability of lung cancer patients and their healthcare spending and utilization using long periods of large dataset is less researched in this country. The purpose of this study was to investigate how different individual and hospital factors are associated with total, inpatient, outpatient spending and utilizations measured by length of stays and outpatient days among nationwide dead or 5 years follow-up lung cancer patients using 2002-2012 health insurance claims data.

Materials and Methods: We used nationwide lung cancer patients' health insurance claims during 2002-2012 which accounted for 1,417,380 (673,122 inpatients and 744,258 outpatients). We transposed the dataset into a retrospective cohort design study that the unit of analysis is information of each lung cancer patient. We included patients who newly diagnosed with lung cancer after 2005 and dead or follow-up of 60 months which eventually included patients diagnosed during 2005-2007. Furthermore, this study also excluded patients who had inpatient spending less than KRW 400,000 to minimize bias of real lung cancer patient selection. We then calculated various spending and utilization measures (total, inpatient, outpatient spending, length of stays and outpatient days). Survival time was also measure for

each patient that the variable is measured by time from diagnosis to all-cause mortality or end of 60 months follow-up. Finally we obtained total population for analysis of 53,451 lung cancer patients and matched 916 hospitals. Hospital data included characteristics of the hospital, such as hospital type, teaching status, number of beds, specialists, and nurses. Cox-proportional hazard model was performed to investigate survival probability of lung cancer patients by using individual factors. In order to investigate individual and hospital factors associated with healthcare spending and utilization of lung cancer patients, multi-level linear mixed models that avoid problems created by possible nesting of patient level observations within hospital clusters and overestimation of significance were performed.

Results: Our retrospective cohort design study using nationwide claim data of past decade showed that increase in new lung cancer cases during year 2005 to 2007 (16,654 in 2005, 18,149 in 2006, 18,648 in 2007 which are similar to actual number of patients reported by national cancer center), increased spending and utilization (total spending of KRW 22,883,645 to KRW 27,462,222; inpatient LOS of 51.4 days to 58.8 days; outpatient utilization of 25.4 days to 26.1 days for patient diagnosed in 2005 and 2007 respectively), and higher proportion of spending and utilization during very first periods after diagnosis and last periods before death or follow-up ends of lung cancer patients (about 70% over total), no significant improvements of 5 years survival rates by year of diagnosis (20.4%, 19.7%, and 20.3% for diagnosed in 2005, 2006, and 2007 respectively, P=0.462) and higher spending and utilization trend among dead population (5-years survivors: total spending of KRW 24,486,381, inpatient LOS of 39.2 days, outpatient utilization of 40.9 days; Dead population: total spending of KRW 15,936,865~54,945,330, inpatient LOS of 44.4~107.8 days, Outpatient utilization of 9.0~66.0 days). Results of Cox-proportional hazard model showed that indifferent hazard ratio by insurance type (health insurance vs. medical aids, HR=0.99, P=0.489), however, hazard ratio was increased for male (female

HR=0.74, *P*<0.001), as older age of diagnosis after 40+ for lung cancer (HR range from 2.02 to 6.63, *P*<0.001). Using the multi-level linear mixed analysis models, we found evidences of differences in the use of healthcare resources among individual and hospital factors that individual with health insurance (2.9% higher in total spending, *P*<0.001; 23.8% higher in outpatient days, *P*<0.001), male (5.6% higher in total spending, *P*<0.001; 8.6% higher in outpatient days, *P*<0.001), 40-79 age group (28.0% to 61.0% higher in total spending, *P*<0.001; 24.8% to 34.0% in LOS, *P*<0.001; 38.9% to 65.8% higher in outpatient days, *P*<0.001) and hospital type with tertiary/large (27.6%, 12.7% higher in total spending), teaching (35.6% higher in total spending, *P*<0.001; 13.4% higher in LOS, *P*=0.001; 21.9% higher in outpatient days, *P*<0.001) had relatively higher spending and utilization among nationwide 5 year follow-up lung cancer patients. Some population groups showed that higher hazard ratios with higher healthcare spending and utilization.

Discussion & Conclusion: This study might suggest that efficient manner of healthcare policy implementation for patients' spending and utilization in order to maintain financial viability of national health insurance program that the allocation of limited health-care resources demands an agreed rational allocation principle, and consequently priority setting is considerably importance. In addition, healthcare spending and utilization considered to be targeted to under-served population groups that will ensure efficient locus of healthcare service delivery by accounting for survival probability of different sub-population groups. Results of this study might be useful to health policy makers not only in South Korea but also international readers that need to develop a national cancer management strategy that reduce differences in the use of healthcare resources and flexible healthcare benefits plan which might helpful to targeted sub population groups.

Key words: Lung Cancer, Healthcare Spending, Healthcare Utilization, Survival

I. Introduction

1. Study Background

Over the past decades, cancer has been the leading cause of death and is associated with the largest disease burden in Korea.[1] Of all cancers, lung cancer has one of the highest fatality rates, and is the leading cause of cancer-related mortality in South Korea[2] and worldwide.[3] World Health Organization reported that 1.8 million new lung cancer cases were estimated in 2012 (12.9% of the total cases of cancer), in the latest GLOBOCAN 2012.[4]

In Korea, the latest statistics show that the numbers of incident lung cancer cases were 21,753 (out of total 218,017 cancer cases; 69.7% male) and prevalent lung cancer cases were 48,795 (out of total 1,097,253 cancer prevalence; 65.3% male) in 2011.[5] In 2013, 75,334 cancer deaths were reported, with lung cancer accounting for 22.8% of all deaths (17,177, 72.8% male) the highest cancer death in both males and females in Korea.[5] Five-year survival rates for lung cancer are about 20% during 2007-2011,[5] one of the lowest survival rates, because most patients had advanced-stage lung cancer at their initial diagnosis.[6]

Economic burden of cancer has increased over the decades because healthcare in general and cancer care in particular are very expensive.[7] Moreover, diagnostic advancement of new cancer care and cancer treatments cause costs that contribute to rising economic burdens for cancer care.[8] Increased costs are outpacing the inflation rates and budgetary level of each nation, hence questions were raised regarding the

cost-benefit of proven interventions by both individuals and society levels.[8] Ideally, more effective and less toxic care and treatments should be initiated, but these innovations require further costs.[9] Ideas of healthcare care costs or expenditure should be utilized efficient manner considering survival probability, severity of illness, and others in order to reduce useless resource usage had been continuously discussed throughout the world for a long period of time.

Healthcare utilization is associated with time close to dying, suggesting that a large proportion of expenditures occur in the last few months prior to death.[10-12] In the United States, healthcare spending in the last year of life consumes approximately 27% to 30% of the Medicare budget and has done so consistently over the past decades.[12,13] Most of these costs were the result of life-sustaining care, with a significant portion of costs accrued from acute care in the final 30 days of life.[13] Healthcare utilization is also associated with cost trend of cancer patients after their diagnosis, using SEER (Surveillance, Epidemiology, and End Results)-Medicare combined dataset, were "U-shaped," with high costs near the times of diagnosis and death, and lower costs in between.[14] Although several research had investigated the spending and utilization of late stage cancer, not many of studies conducted in this country.

Healthcare spending and utilization might be influenced by health insurance type or various health policy initiatives. The Korean government introduced mandatory social health insurance for employees of large corporations in 1977 and achieved universal health insurance program in 1989.[15] Since health insurance program in South Korea is controlled exclusively by the government under a single-payer system,[16] even with the universal coverage through the mandatory National Health Insurance (NHI), only

54.5% of total health expenditures are associated with the public sector, comparing to 72.3% for OECD countries as of 2012.[17] Korea also faces with health care spending issue that the highest rate of growth, more than twice the OECD average.[17] Total health expenditures in South Korea accounted for 7.6% of GDP in 2012. It ranks 27th among the 34 OECD (Organization for Economic Co-operation and Development) countries that percentage of total health expenditure is lower than the OECD average of 9.3%, however, the increase in its health expenditure rate is 9.3%, which is higher than that of most OECD countries.[17]

However, NHI members still need to pay high out-of-pocket payment (copayments) and full payment for uncovered services, to some extent related to fee-for-service reimbursement system that might supplier induces demand and relatively fast adoption of state-of-art technologies.[16] Since cancer is associated with expensive treatments, drugs, and other diagnostic procedures, NHI initiated various copayment policies over a decade to alleviate patients' financial burden. In January 2004, NHI initiated a copayment policy that limits copayments to 20% for cancer patients in outpatient services where normal copay is 50%. In September 2005, the coverage was expanded to 10% copayments for both inpatient and outpatient services for cancer patients. In December 2009, the coverage was expanded again to 5% copayments for both inpatient and outpatient services.[18] Recently, coverage for four major serious disease including cancer has been more expanded; however, there are no mechanisms of controlling rising healthcare expenditure among those patients groups.

In order to investigate patients' healthcare spending and utilization mechanism associated with health insurance coverage, the landmark RAND health insurance experiment conducted in the late 1970s randomized families to different health

insurance plans that varied in their cost-sharing. They found that families subjected to higher cost-sharing reduced the use of health services virtually across the board, including fewer physician visits and fewer adult inpatient hospital stays, less preventive and non-preventive care, and less use of both effective and non-effective care.[19,20] There are similar findings in a pediatric population.[21] The study results might suggest that unplanned coverage expansion would cause unplanned healthcare spending utilization increase.

As the population of patients with lung cancer increases, the expenditure on lung cancer treatments is a huge economic burden.[22] Only few studies have been conducted in Korea that investigated socio-economic costs of cancer treatment. A study conducted in 2008 by Kim et al., from the National Cancer Control Research Institute, they estimated the economic burden of all cancer in Korea in 2002 at $9.4 billion which accounted for 1.72% of the gross domestic product (GDP) and lung cancer accounted for $1.3 billion[23] which is huge burden for entire country. Recently, Park et al. found evidences that the economic burden of cancer in Korea showed a rapid rise from USD 11,424 million in year 2000 to USD 20,858 million in year 2010 which accounted an average annual growth rate of 8.9%.[24] Although economic burden of lung cancer has drastically increased, Korea achieved universal NHI program decades ago, it is roughly 10 years since the various cancer related insurance policies, and 10-year plan for cancer patient control (Figure 1) have been implemented, however, there has been no comprehensive investigation into nationwide healthcare spending and utilization and its associated factors for lung cancer patients yet.

In addition, the studies on lung cancer epidemiology are well-documented, but the factors that associated with survival time of lung cancer patients and their healthcare

spending and utilization using long periods of large dataset is also less researched in this country. In addition to investigation of patients' healthcare spending and utilization, association with hospital factors is also very important as 70% of deaths occur at hospitals in Korea.[25] Although patients with advanced cancer prefer to receive care and die at home,[26,27] most patients die in hospitals.[26-31]

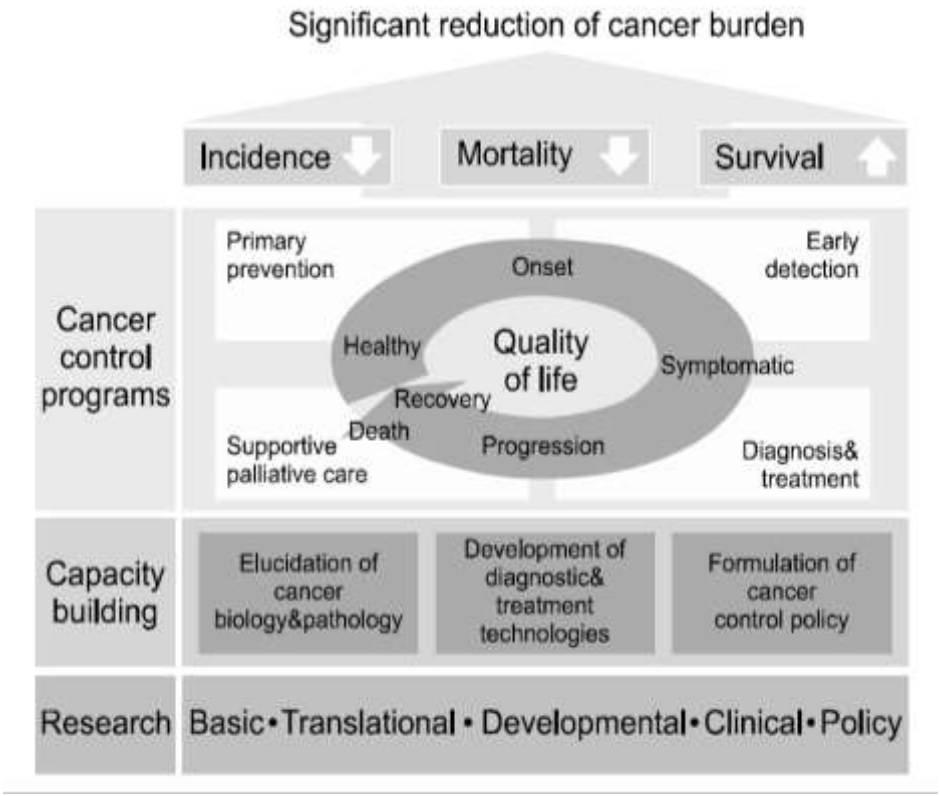

Figure 1. Second 10-year plan for cancer patient control[32]

The structure and availability of healthcare resources appear to influence place of death more than the actual preference of patients and families.[33,34] Furthermore, South Korea is ranked second highest in average hospital length of stay followed by Japan and the highest in outpatient visits among OECD countries[17] which provide important

research rationale for investigating hospital level factors of healthcare spending and utilization.

The main purpose of this study is to investigate and hypothesize various individual and hospital level factors that influence healthcare spending and utilization and its relation to translated health outcomes measured by survival probability of lung cancer patients. We believe the research findings will prove useful to health policy makers that the allocation of limited health-care resources demands an agreed rational allocation principle, and consequently priority setting is of considerable importance,[35] especially those residing in countries with national health insurance programs based on fee-for-service payments, and others concerning cancer management policy. The findings will add to mounting evidence of the need to develop a national cancer management strategy.

2. Study Objectives

The purpose of this study is to investigate how different individual and hospital factors are associated with total, inpatient, outpatient spending and utilizations measured by length of stays, outpatient days among nationwide 5 years follow-up of lung cancer patients using 2002-2012 health insurance claims data.

The detailed objectives of this study were as follows:

(1) To analyze how different types of patient factors including age group strata, sex, types of insurance, duration of diagnosis to death etc. affected total, inpatient, outpatient spending and utilizations measured by length of stays and outpatient days among nationwide 5 years follow-up lung cancer patients using 2002-2012 health insurance claims data.

(2) To analyze how different types of hospital factors including type of hospital, teaching status, and other structural factors affected total, inpatient, outpatient spending and utilizations measured by length of stays and outpatient days among nationwide 5 years follow-up lung cancer patients using 2002-2012 health insurance claims data.

(3) To analyze how different types of patient factors including age group strata, sex, types of insurance etc. affected survival probability of nationwide 5 years follow-up lung cancer patients using 2002-2012 health insurance claims data.

II. Literature Review

1. Factors associated with spending and utilization for lung cancer patients

Previous research found evidences that treatment intervention with surgery, chemotherapy, or radiotherapy has been shown to improve lung cancer survival.[36] In addition, the recent literature contains numerous reports of factors affecting the diagnosis, treatment and outcomes of lung cancer across a growing list of population subgroups, including race and ethnicity, sex, income, and place of residence etc.

Regarding the issue of spending and utilization with lung cancer patients, international research primarily focused on racial or ethnicity factors on lung cancer utilization. A study conducted by Bach et al., using the Surveillance, Epidemiology, and End Results (SEER) data between 1985 and 1993 in United States, found evidences of utilization differences that the lower rate of surgery found in black patients by 12.7 percentage than for white patients (64.0 percent vs. 76.7 percent, P<0.0 01).[37] Lathan et al. also examined racial differences of lung cancer treatment and found evidences that rate of surgery for black patients is lower than whites patients among lung cancer patients, even after access to care has been demonstrated. Further, the black patients are more likely to refuse surgery and not to have surgery recommended by the way.[38] However, other studies found that nonwhites also tended to have higher treatment costs than whites, although they had significantly shorter survivals.[39]

In addition to racial/ethnic differences, age was also played a role for factors

influencing lung cancer utilization. Using the data of the Virginia Cancer Registry (VCR), 1985-89, Smith et al. found the evidences that increasing age was associated with lower likelihood of receiving therapy (OR=0.35), thoracotomy (OR=0.27), and more use of radiation therapy compared to surgery (OR=1.69) when they matched the VCR with claims from Medicare Part A and B, census tract data and the Area Resource File.[40] Using the population-based random sample of newly diagnosed lung cancer patients, diagnosed within 10 separate geographic areas, Potosky et al. concluded that the use of recommended therapy was significantly inversely associated with age, further, stage-specific analyses revealed a significant decline in the use of recommended surgery with increasing age at diagnosis for early-stage lung cancer.[41]

Furthermore, lower education were associated with less likelihood of receiving treatment (OR=0.78), or radiation instead of surgery (OR=1.22) and patients in urban areas were less likely to receive therapy (OR=0.67).[40] Large variations exist in the use of therapies according to age, race or ethnicity, and marital status in another study.[41]

Access for healthcare utilization is very significant issue in lung cancer patient. People within lower socio-economic status, especially lower income status, more likely person experiences a broad spectrum of problems and being poor will not only diminish access to medical care and treatment but also have poorer housing, less social support, and a risk-promoting lifestyle, with a greater likelihood of smoking.[42]

Black race, probably acting as a proxy for lower socioeconomic status, was associated with both a less likely seeing a cancer specialist and subsequently receiving chemotherapy. After seeing such a physician, treatment decisions seem to be mostly explained by appropriate medical factors, however, racial and socioeconomic differences still exist at both steps.[43]

Insurance status also played a significant role for factors influencing healthcare utilization of lung cancer patients' treatment and patients with lung cancer who do not have insurance have been shown to have more limited access to care, since insurance coverage is an important determinant of access to care and is one potential cause of differences in lung cancer care outcomes. Silverstein et al. found evidences that residence in an area with a high proportion of Medicaid recipients was a predictor of advanced stage in esophageal cancer patients; further, decreased utilization of health services was evident among older, poor, black, rural cancer patients.[44]

A systematic review also showed that examined the association between insurance status and lung cancer practices and outcomes concluded that comparing with patients with private or Medicare insurance, patients with Medicaid or no insurance had poorer lung cancer outcomes, including higher incidence rates, later stage at diagnosis, and poorer survival.[45] Their conclusion was that some of the differences may be secondary to residual confounding from smoking and other health behaviors, but available data suggest that patients with lung cancer without insurance do poorly because access to care is limited and/or they present with more advanced disease that is less amenable to treatment.[45] In the domestic research, the authors also found evidences that individuals with private health insurance spent larger inpatient costs than those without, but no differences were found in utilization in other service such as hospital admissions, hospital days and physician visits.[46] Sex differences in the development and treatment of lung cancer is another very critical issue. The Society for Women's Health Research hosted a thought leaders' roundtable to review issues and advances related to sex differences and presented recent data on the epidemiological aspects of lung cancer in women, lung tumor biology, and emerging

trends in clinical research in 2006.[47] In other study, women tended to have higher treatment costs than men; they also had more favorable survivals using linked SEER-Medicare data were used to construct cost profiles by service type and treatment phase for roughly 80,000 incident lung cancer cases in patients aged 45 to 85 years at diagnosis.[39] Recently research done by Forrest et al., the study concluded that socioeconomic inequalities in lung cancer treatment using systematic review and meta-analysis method.[48] Specifically, the study showed that patients with lung cancer living in more socioeconomically deprived circumstances are less likely to receive any type of treatment, surgery, and chemotherapy, further, these inequalities cannot be accounted for by socioeconomic differences in stage at presentation or by differences in health care system by analyzing forty-six papers which met inclusion criteria.[48]

In contrast to previous research, some studies concluded that socio-economic positions are not related to lung cancer utilization. The study conducted in England, using population-based cohort identified in the Thames Cancer Registry in which 15,582 lung cancer patients diagnosed between 2006 and 2008 included, found evidences that the likelihood of being diagnosed as having early-stage disease did not vary by socioeconomic quintiles and differences which could not fully be explained by social differences in stage at diagnosis, co-morbidity and treatment.[49] In other study conducted in New Zealand also concluded that socio economic position was not associated with receipt of any treatments using the data analysis of the New Zealand Cancer Registry.[50] International research found evidences primarily that the differences exist among different groups of population. Not only in this country but also international health policy makers identify reducing these differences as a critical priority.[51]

Although patient level factors associated with healthcare spending and utilization of patients were well researched, hospital level factors were less researched. Only few studies examined that hospital characteristic especially for teaching status and hospital type associated with higher spending and utilization. Teaching hospitals were historically commanded high payment rates more than its counterparts in order to support their cost structure because of their reputations for providing high-quality healthcare, their specialized health service capacity, and education of medical students.[52,53] In addition, large hospitals may include a greater share of physicians, nurses, allied health professionals and other ancillary costs.[54]

2. Factors associated with survival probability for lung cancer patients

Lung cancer epidemiology study showed that survival differs internationally. In the UK, fewer than 10% of lung cancer patients diagnosed survive more than 5 years, although higher survival rates found in Nordic countries, the USA, Australia, and Canada.[55,56] The international range in conditional 5-year survival seems to have widened.[56] Lung cancer has become the number one killer among cancers worldwide. Although lung cancer remains the leading cause of cancer-related mortality in the United States, its incidence is decreasing. In 2008, 215,020 new cases were expected and 161,840 persons were projected to die from the disease in the United States. Non–small cell lung cancer accounts for most lung cancer and carries a 5-year survival rate of 15%.[57]

Strong evidence for socio-economic differences in cancer survival and mortality was revealed few decades ago by a comprehensive review in the late 1990s, for many

cancers and in many populations.[58] These variations were resilient to the variety of ways in which socio-economic status had been determined. Possible reasons for survival differences between social groups were also reviewed.[59] Stage at diagnosis was the factor most often cited, but its influence varied by anatomic site and between populations, and it was not the sole explanatory factor for socio-economic differences in survival in much of the research. In the research the authors also concluded that further study into the causes of socio-economic differences in survival was required, particularly in relation to treatment differentials and psychosocial factors.[59]

The racial factor is seen primarily in men and is significantly greater in younger age groups. Gadgeel et al. concluded that a significant racial difference in survival rates has developed over the past 30 years and suggested possible reasons for racial differences due to smoking habits, socioeconomic variables, and the metabolism of tobacco carcinogens although higher lung cancer incidence rates in blacks remains unclear.[60] Many other studies have focused on socioeconomic status of African Americans as the sole cause of these differences. Other studies, however, have identified additional factors related to risks for poor outcomes in blacks with lung cancer.[61] Socioeconomic inequalities in incidence of, and survival from, the majority of cancers also have been reported.[62] A recent nonsystematic review revealed socioeconomic inequalities in receipt of treatment for colorectal cancer,[63] and it has been suggested that socioeconomic differences in access to treatment might at least partially explain socioeconomic differences in survival.[64] Although incidence of lung cancer is higher and survival poorer in the most deprived patient groups,[62] unintended variations in outcome that result from the way that health interventions are organized and delivered have been described as intervention-generated inequalities.[65]

Recently, survival improved for most cancers, but inequalities in survival were still wide for many cancers in 2006 (Only the deprivation gap in 1-year survival narrowed slightly over time). A majority of the socioeconomic differences in survival occurred soon after a cancer diagnosis, regardless of the cancer prognosis.[62] Using the SEER data between 1985 and 1993 in United States, Bach et al. found evidence five-year survival rate was also lower for blacks (26.4 percent vs. 34.1 percent, $P<0.001$).[37] Another study found evidences that 5-year conditional survival rates increase for all ethnicities as time from diagnosis increases, but African Americans continued to have lower conditional survival rates compared with other ethnic groups, even up to 5 years from diagnosis.[66]

Insurance status also played a role that possible reasons for uninsured and Medicaid insured cancer patients' poorer survival compared with privately insured cancer patients, even after adjustment for other factors.[45] Suggested reasons may include that "poorer health with more comorbidity and unhealthy behaviors, no or inadequate preventive health care and management of chronic conditions prior to cancer diagnosis, barriers to receiving treatment and adhering to a treatment regimen such as high cost, inability to navigate the health care system, misinformation about and mistrust of the health care system, lack of a usual source of health care, lack of transportation, lack of time off from work, no treatment or delay in receiving treatment, not all providers accept uninsured or Medicaid insured patients, and lower quality treatment by providers primarily serving the uninsured and Medicaid insured." [45,67-70] Sex differences in lung cancer survival also presented by analysis based on nationwide population-based sample, which concluded that elderly women with early lung cancer had better risk-adjusted survival regardless of the type of treatment.

Hence, sex differences were observed among untreated patients suggests that lung cancer in women may have a different natural history.[71] Age is another major determinant of cancer risk and it is know that the peak of incidence was noted in the cohort of patients aged 60–69 years.[72] The recent study conducted by Riihimäki et al. presented that significant impact of age at diagnosis on the survival of 17,431 lung cancer patients in which concluded deceasing survivals among lung cancer patients of nationwide Swedish Cancer Registry who diagnosed 2002–2010.[73] Although patient level factors associated with survival probability of patients were well researched, hospital level associations were not researched yet.

Previous literatures are conceptualized in the figure 2 that various individual and hospital level factors are associated with not only healthcare spending and utilization but also survival probability of lung cancer patients by using mainly each country's large sized cohort dataset.

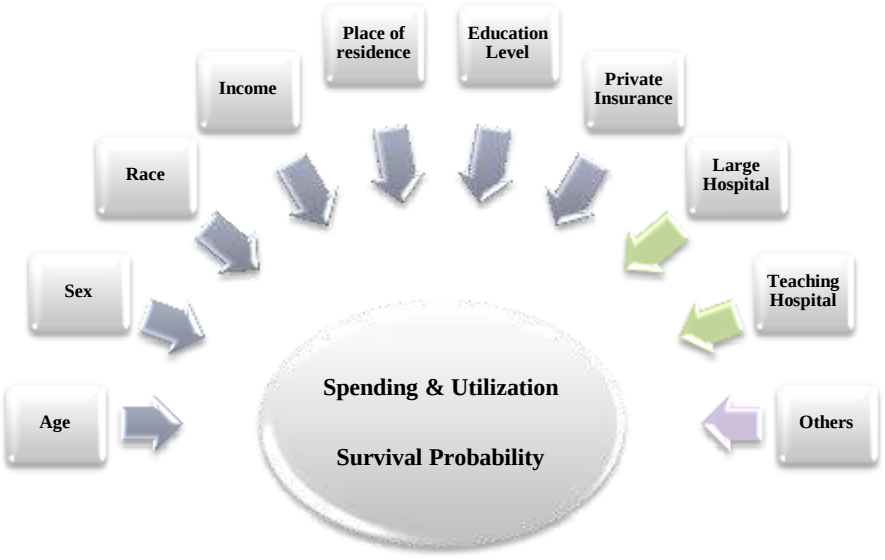

Figure 2. Conceptual Framework of factors associated with healthcare spending and utilization, survival probability of lung cancer patients.

III. Material and Methods

1. Study Population and Design

We collected the nationwide lung cancer inpatient and outpatient claims data between 2002 and 2012 to investigate healthcare spending, utilizations, and its associations with individual and hospital level factors. Lung cancer patients were defined by ICD-10 (International Classification of Diseases-10) codes of C33-C34. This dataset contained health insurance claim details including inpatient, outpatient spending covered by NHI, length of stay, outpatient days, admission and discharge date, outpatient utilization date, date of death (all-cause mortality), age, sex, days in the Intensive Care Unit (ICU), days on a ventilator during hospitalization, and hospitals where patients utilized healthcare resources.

Total numbers of nationwide lung cancer patients' health insurance claims during 2002-2012 were 1,417,380 which included 673,122 inpatients and 744,258 outpatients. Then we matched the patients' claims data with hospital characteristics data by hospital ID number. Hospital level data contained hospital id, hospital type (tertiary, large, small), teaching status (resident teaching hospital vs. non-teaching hospital), and other structural factors including number of beds, number of nurses, number of specialists. After the matching, we transposed the dataset to a retrospective cohort design with the baseline as diagnosis of each patient.

In order to measure follow-up duration and initial diagnosis time of each patient, we calculated those time variables using the dataset. Using all the previous claims, we

identified each year's new lung cancer cases. For example, we searched all claim records of 2002-2004 in order to detect new lung cancer cases in year 2005. If a patient had no record in 2002-2004, then we assumed the patient was newly diagnosed in 2005. Likewise we searched all claim records of 2002-2005 in order to detect new lung cancer cases in year 2006. If a patient had no record in 2002-2005, then we assumed the patient was newly diagnosed in 2006.

We excluded patients diagnosed during year 2002-2004 in order to ensure the newly diagnosed lung cancer cases. The assumption behind this method is that patients will utilize healthcare resources at least once in 3 years after lung cancer diagnosis. Then we also excluded patient diagnosed with lung cancer during 2008-2012, in order to include only patient who followed-up until 60 months. We also excluded patients who spent less than KRW 400,000 assuming that lung cancer patients at least admitted to hospital and spent certain amount for inpatient healthcare resources. Finally, we obtained total population for analysis of 53,451 lung cancer patients who newly diagnosed lung cancer during year 2005 to 2007 and matched 916 hospitals after we excluded missing individual and hospital variables. The figure 3 shows flow chart how total populations for analysis were obtained.

We also calculated total, inpatient, outpatient spending and utilization related to their followed up periods, specific periods of time after diagnosis (example. 3 months before follow-up ends, 6 months before follow-up ends, and 12 months before follow-up ends), specific periods of time before death or end of follow up (example: 3 months after diagnosis, 6 months after diagnosis, and 12 months after diagnosis).

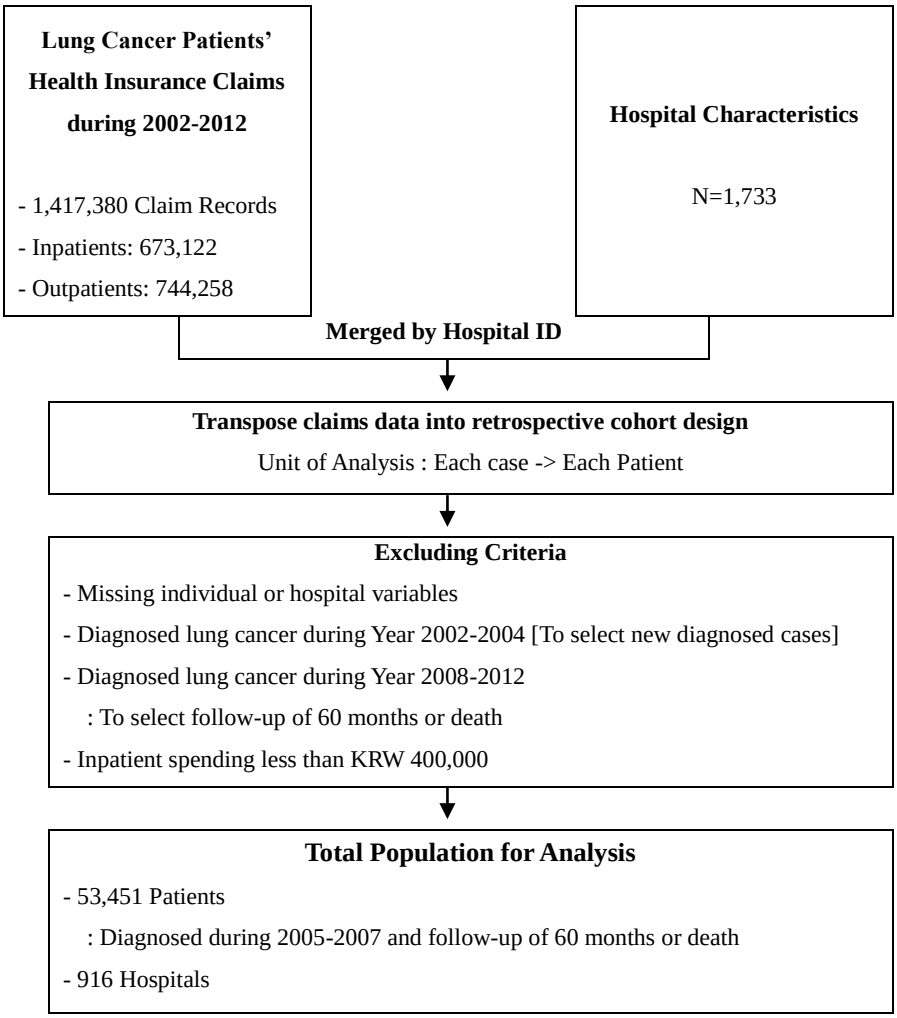

Figure 3. Flow Chart of Subject Selection

Using the conceptual framework of study design (Figure 4), we ought to find factors associated with spending and utilization of nationwide lung cancer patients.

As noted, there's only few studies have examined and evaluated healthcare spending and utilization for nationwide lung cancer patients and their survival probability in South Korea using relatively large and long period of health insurance claim dataset.

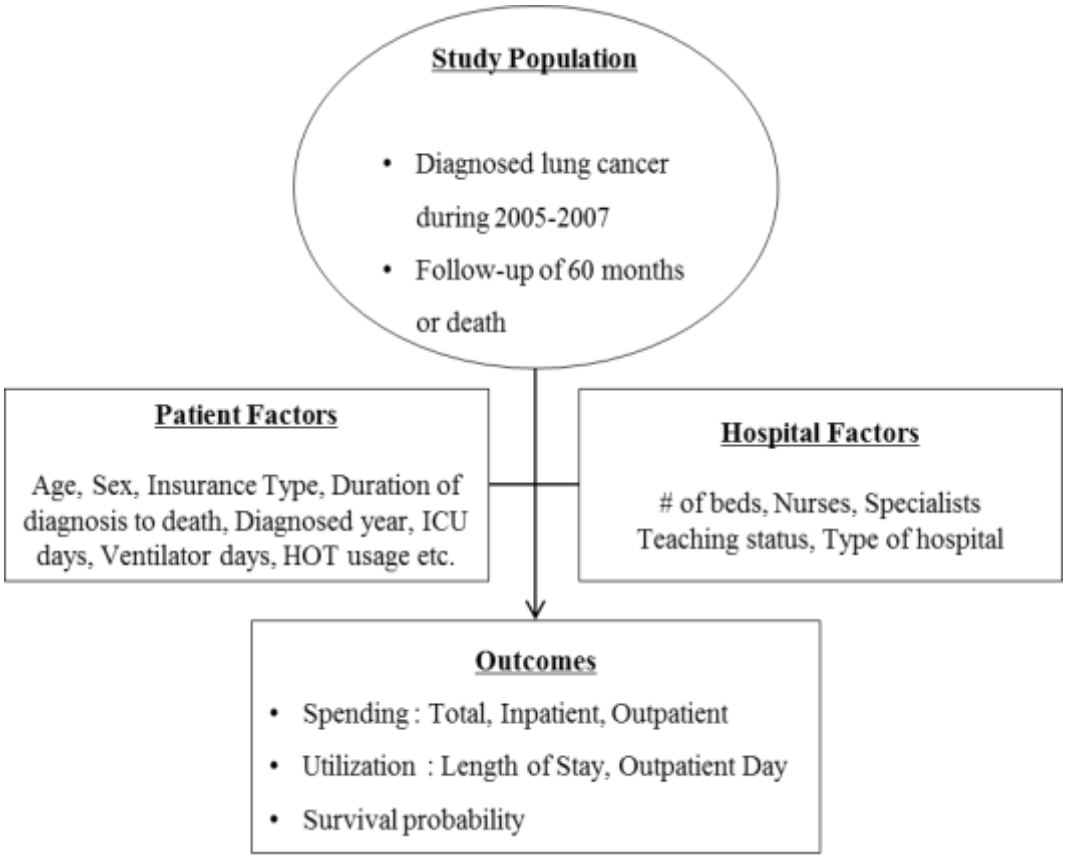

Figure 4. Conceptual Framework of study design

2. Patient and Hospital Level Variables

In order to investigate spending and utilization of nationwide lung cancer patients, we aggregated claims associated with spending and utilization from each patient's diagnosis of lung cancer. We also calculated survival or follow-up times of each lung cancer patient using the date of death and end of follow-up date (2012.12.31). Dependent variables were basically divided into two sections that spending and utilization. Our lists of dependent variables were described in table 1.

Table 1. Lists of Dependent Variables

Category		Variables
Dependent Variables	Spending	- Total spending during follow-up periods - Inpatient spending during follow-up periods - Outpatient spending during follow-up periods
	Utilization	- Inpatient LOS during follow-up periods - Outpatient Days during follow-up periods

Inpatient and outpatient healthcare spending is the sum of Fee-For-Services (FFS) claims for each patient's hospitalization and outpatient visit. South Korea established a national health insurance (NHI) program in 1989; all types of hospital generally use a fee-for-service (FFS) reimbursement system. Patients have considerable freedom to choose and access care providers; no restrictions on the use of primary, secondary, and tertiary medical institutions and there are no penalties for repeated care.[74,75]

In Korea, the fee for services (FFS) catalogue is negotiated by the government, providers, and other stakeholders every year. We discounted all inpatient and outpatient spending to 2012 levels using each year's negotiated FFS catalogue. The yearly mean of the foreign exchange (FX) rate was 1USD = 1126.88 KRW in year 2012. Furthermore, we also converted spending information in order to have realistic numbers. In Korea, coverage for cancer patients have been different by years (table 2), we estimated total spending which include covered spending from claim data and non-covered spending from estimation. Dependent variable as specific periods of time after diagnosis (ex. 3 months before follow-up ends, 6 months before follow-up

ends, and 12 months before follow-up ends), specific periods of time before death or end of follow-up (ex. 3 months after diagnosis, 6 months after diagnosis, and 12 months after diagnosis) is also assessed but included in the appendix.

Table 2. NHI coverage for cancer patients (both inpatient, outpatients) after 2005

Year	Inpatient	Outpatient
2005	63.0	75.9
2006	69.7	73.9
2007	70.1	75.7
2008	70.8	71.6
2009	63.9	79.8
After 2010	69.0	75.1

Source: Statistics Korea. 2013

The dataset also contained patient level health insurance claim details including admission date, outpatient visit date, age group, sex, insurance type, Intensive Care Unit (ICU) days and days on ventilator during hospitalization, status of respiratory disability, and usage of home-oxygen therapy. Lists of patient level variables are contained in table 3. Age variable grouped into eight categories in order to see specific age effect on healthcare spending and utilizations. Type of insurance is a proxy measure of socio-economic-status (SES) in Korea, we used as the variable as patient's SES in this study. ICU days and ventilator days were also aggregated into specific period of time like as dependent variable were calculated. This study also included diagnosed year of lung cancer for each patient. In order to adjust severity of

patients, we also included a variable, death after diagnosis, that present specific survival time of each dead lung cancer patients or 5 years survivors.

Table 3. Definitions of patient level variables

	Variables	Definition
Patient Level	Age group	(1) ≤19 (2) 20–29 (3) 30–39 (4) 40–49 (5) 50–59 (6) 60–69 (7) 70–79 (8) 80≤
	Sex	(1) Men (2) Women
	Type of Insurance	(1) National Health Insurance (2) Medical Aid
	Duration of Diagnosis to Death or F/U end	(1) Within a year (2) During 1-1.99yrs (3) During 2-2.99yrs (4) During 3-3.99yrs (5) During 4-4.99yrs (6) 5yrs survivors
	Diagnosed Year	(1) 2005 (2) 2006 (3) 2007
	Home Oxygen Therapy	(1) User (2) Non-User
	Respiratory Disability	(1) Disabled (2) Non-Disabled
	ICU days	Total number of days using ICU
	Ventilator days	Total number of days using ventilators

Hospital-level data included characteristics of the hospital, such as hospital type (tertiary, large, small), teaching status (teaching and non-teaching), number of beds, number of specialist physicians, number of nurses. Lists of hospital variables are included in the table 4. We used hospitals data where patients were lastly admitted to.

According to the Korean Hospital Association (KHA), Korean hospitals are categorized as tertiary university research hospitals, mid-sized general hospitals, or small-sized general hospitals based on the number of beds and medical departments.

Tertiary university research hospitals contain more than 1000 beds and almost all possible medical departments, and mid-sized general hospitals typically contain more than 300 beds and nine major medical departments or more than 100 beds and seven major medical departments. Hospitals with fewer than 100 beds or a shortage of medical departments are classified as small general hospitals.[76] We categorized hospital type into those three groups based on the criteria (tertiary hospital, large hospital, small hospital). Teaching status defined as whether hospitals have resident training programs.

Table 4. Definitions of hospital variables

	Variables	Definition
Hospital Level	Hospital Type	(1) Tertiary Hospital (2) Large hospital (3) Small hospital
	Teaching status	(1) Teaching (2) Non-Teaching
	Number of beds	Total number of general ward's beds
	Number of nurses	Total number of registered nurses
	Number of specialist physicians	Total number of specialist physicians

3. Statistical Analysis

We first examined number of newly diagnosed 5 years follow-up lung cancer patients and their characteristics. In order to investigate characteristics of nationwide lung cancer patients, descriptive statistics were generated; means and standard deviations were calculated for continuous variables, and frequencies and relative percentages were calculated for categorical variables. Means of survival time or follow-up periods for survivors by patient's characteristics were also examined. Bi-variate analyses were conducted to see group difference for example, age group, sex, duration of diagnosis to death, diagnosed year, insurance type, usage of home-oxygen therapy, and respiratory disability rating etc. We also investigated various spending and utilization measures including 1) Spending and utilization by characteristics of patients, 2) Spending and utilization by patients' time stages of lung cancer patients, and 3) Spending and utilization by periods before death and after diagnosis of lung cancer patients.

We then examined the crude association between each patient characteristic and survival probability of lung cancer patients by using Kaplan–Meier curves. To investigate the associations of all patient characteristics and spending with survival probability of lung cancer patients, Cox proportional hazard models were used to calculate hazard ratios and the corresponding 95% confidence intervals. In this study, a P-value less than 0.05 (two-tailed) were considered statistically significant.

We used multi-level mixed models by employing SAS's "Proc Mixed" procedure and random intercept effects that accounted for hierarchical data structure. The unit of analysis is each patient who is nested within a hospital and the model analyze the

patient-, hospital- level characteristics together. We used the model in order to avoid problems created by possible nesting of patient level observations within clusters (hospitals) and overestimation of significance. We adjusted patient- and hospital-level confounders in order to investigate individual and hospital factors that influence spending and utilization of nationwide lung cancer patients. We first examined total, inpatient, outpatient spending then also investigated association with utilization measured by inpatient days (hospital length of stay) and outpatient days. Both random intercept and maximum-likelihood option were also employed to run the models.

Additionally, we conducted multi-level mixed models by taking specific period before dead or end of follow-up and specific periods after diagnosis as dependent variables which were included in Appendix C and D. All of dependent variables were skewed because the data include spending and utilization information, we took the natural log for each dependent variable. Distribution of each dependent variable and it natural log distribution is presented in Appendix B.

SAS 9.3 (SAS Institute, Cary, NC) was used for all calculations and analyses. All statistical tests were two-tailed, and we rejected null hypotheses of no difference if p-values were less than .05, or, equivalently, if the 95% CIs of risk point estimates excluded 1.

4. Ethics Statement

This study was approved by an institutional review board of Graduate school of Public Health, Yonsei University. [IRB Number: 2014-203]

IV. Results

1. Characteristics of Patients and Hospitals

The results of descriptive analysis of nationwide 5 years follow-up lung cancer patients and hospitals where the patients were admitted to were included in this section. The numbers of newly diagnosed lung cancer cases during 2005-2007 in Korea were presented in table 5. During the year 2005 to 2007, 53,364 of new lung cancer patients were diagnosed with lung cancer by national cancer center (NCC). Similarly, this study identified 53,451 cases (differences of 81 patients comparing to NCC report) using the methodology used to identify lung cancer patients in this study using nationwide health insurance claims data.

Table 5. Comparison of new lung cancer cases during 2005-2007 in Korea.

	Year			Total
	2005	2006	2007	
Reported by National Cancer Center	17,229	17,725	18,410	53,364
In this Study	16,654	18,149	18,648	53,451

Characteristics of 5 years follow-up lung cancer patients diagnosed during 2005-2007 in Korea showed in table 6. Total numbers of patients were 53,451. Age of diagnosis with lung cancer was highest in 70-79 (32.8%), followed by 60-69 (32.2%), 50-59 (15.4%). Age 80+ was accounted 11.7% which is fourth raked in number of new lung cancer cases among different age group strata. Male were 38,046 which

accounted for 71.2% of total patients. Among 53,451 patients, 48,586 had national health insurance program (90.9%) and 15,405 enrolled in medical aids program (9.1%). About 52% of patients were dead with a year of lung cancer diagnosis, 68% of them were dead within 2 years of diagnosis. 5 years survivors were accounted for 20.1%. Numbers of lung cancer patients were slightly increased during 2005 to 2007. Small numbers of patients were received respiratory disability grading (0.8%), and home-oxygen therapy (2.1%). Means and standard deviation of episode spending and utilization were also presented in table 6.

Mean total spending was KRW 25,451,471 which composed of inpatient spending of KRW 18,338,230 and outpatient spending of KRW 7,113,241. Mean episode ICU days were 1.7 days and ventilator days were 1.2 days. Nationwide lung cancer patients utilized average 56.0 days of inpatient services and 25.9 days of outpatient days in their 5 years of follow-up.

Table 6 shows that follow-up time of lung cancer patients by different types of characteristics who diagnosed lung cancer during 2005-2007 in Korea. Mean follow-up time of lung cancer death was 21.7 months. Older patients had relatively shorter follow-up time than younger groups. The trend is gradually increased as getting younger. Patients who had health insurance (22.0 months Vs. 18.8 months of medical aids), female (25.5 months Vs. 20.1 months of male), having disability status (27.0 months Vs. 21.7 months of non-disabled), using home-oxygen therapy (26.2 months Vs. 21.6 months of non-users) were longer in their follow-up time. Patient's follow-up time by diagnosed year of lung cancer was quite similar (21.9 months in 2005, 21.5 months in 2006, and 21.7 months in 2007).

Table 6. Characteristics of 5 years follow-up lung cancer patients who diagnosed during 2005-2007

		N/Mean	%/SD
Total		53,451	100
Age Group			
	80-	6,259	11.7
	70-79	17,543	32.8
	60-69	17,219	32.2
	50-59	8,206	15.4
	40-49	3,300	6.2
	30-39	738	1.4
	20-29	137	0.3
	-19	49	0.1
Sex			
	Male	38,046	71.2
	Female	15,405	28.8
Insurance Type			
	Health Insurance	48,586	90.9
	Medical Aids	4,865	9.1
Home-Oxygen Therapy			
	User	1,138	2.1
	Non-User	52,313	97.9
Respiratory Disability			
	Disabled	414	0.8
	Non-disabled	53,037	99.2
Death After Diagnosis			
	Within a year	27,692	51.8
	During 1-1.99 years	8,360	15.6
	2-2.99 years	3,562	6.7
	3-3.99 years	1,873	3.5
	4-4.99 years	1,208	2.3
	5 yrs Survivors	10,756	20.1
Diagnosed Year			
	2005	16,654	31.2
	2006	18,149	34.0
	2007	18,648	34.9
ICU Days*		1.7	7.3
Ventilator Days*		1.2	6.7
Total Spending*		25,451,471	27,124,232
Inpatient Spending*		18,338,230	19,716,931
Outpatient Spending*		7,113,241	13,468,481
Inpatient LOS*		56.0	71.0
Outpatient Days*		25.9	34.7

*** Mean/SD**

Table 7. Follow-up time of lung cancer patients who diagnosed during 2005-2007 by difference of characteristics.

		Mean	SD
Total		21.7	22.4
Age Group			
	80-	11.4	16.9
	70-79	16.8	20.1
	60-69	23.8	22.7
	50-59	29.6	23.5
	40-49	32.7	23.5
	30-39	32.9	23.6
	20-29	36.5	24.3
	-19	43.3	23.6
Sex			
	Male	20.1	21.6
	Female	25.5	23.8
Insurance Type			
	Health Insurance	22.0	22.5
	Medical Aids	18.8	21.5
Home-Oxygen Therapy			
	User	26.2	19.5
	Non-User	21.6	22.4
Respiratory Disability			
	Disabled	27.0	22.4
	Non-disabled	21.7	22.4
Death After Diagnosis			
	Within a year	4.5	3.3
	During 1-1.99 years	17.0	3.4
	2-2.99 years	29.2	3.4
	3-3.99 years	41.5	3.4
	4-4.99 years	53.8	3.5
	5 yrs Survivors	60.0	-
Diagnosed Year			
	2005	21.9	22.4
	2006	21.5	22.3
	2007	21.7	22.5

Table 8 depicts characteristics of hospitals where 5 years follow-up lung cancer patients diagnosed during 2005-2007 were admitted to in Korea. Number of beds was around 350 beds and number of nurses was 111.1. Average specialist

physicians were 38.9. Most of hospitals were non-teaching hospitals (N=774, 84.5%) and tertiary hospitals, large hospitals, and small hospitals accounted for 4.8%, 31.1%, 64.1%, respectively.

Table 8. Characteristics of hospitals where 5 year follow-up lung cancer patients diagnosed during 2005-2007 were admitted to

	Mean/N	SD/%
# of Beds	351.5	319.9
# of Nurses	111.1	193.9
# of Specialist physician	38.9	77.5
Teaching Status*		
Teaching	142	15.5
Non-Teaching	774	84.5
Hospital Type*		
Tertiary	44	4.8
Large	285	31.1
Small	587	64.1

*** N/%**

Table 9 presents characteristics of 5 years follow-up lung cancer patients by duration of diagnosis to death. More of older patients were dead within a year of diagnosis of lung cancer. Male population was dead more within a year of diagnosis of lung cancer (54.5% of male vs. 45.2% of female) and their 5 year survival rate was lower than female (17.8% vs. 25.8%). Health insurance holders had lower mortality within a year of lung cancer diagnosis (51.1%), and their 5 years survival rate was also higher than medical aids holders (20.5% vs. 16.1%). 5 years survival rate of lung cancer patient who diagnosed during 2005 to 2007 was not significantly different in this study (about 20 months, P=0.463). Home oxygen therapy usage and respiratory disability grade also had different 5 year survival rates (P<0.001).

Table 9. Characteristics of 5 years follow-up lung cancer patients by duration of diagnosis to death or follow-up end

		Total	Duration of diagnosis to death or follow-up end												P
			Within a year		1-1.99 years		2-2.99 years		3-3.99 years		4-4.99 years		5 yrs Survivors		
			N	%	N	%	N	%	N	%	N	%	N	%	
Age Group															
	80-	6,259	4,643	74.2	662	10.6	287	4.6	146	2.3	99	1.6	422	6.7	<.0001
	70-79	17,543	10,863	61.9	2,533	14.4	1,020	5.8	504	2.9	343	2.0	2,280	13.0	
	60-69	17,219	8,067	46.8	2,976	17.3	1,206	7.0	613	3.6	457	2.7	3,900	22.6	
	50-59	8,206	2,896	35.3	1,462	17.8	677	8.3	390	4.8	193	2.4	2,588	31.5	
	40-49	3,300	970	29.4	562	17.0	300	9.1	176	5.3	103	3.1	1,189	36.0	
	30-39	738	210	28.5	136	18.4	64	8.7	35	4.7	13	1.8	280	37.9	
	20-29	137	34	24.8	24	17.5	7	5.1	6	4.4	-	-	66	48.2	
	-19	49	9	18.4	5	10.2	1	2.0	3	6.1	-	-	31	63.3	
Sex															
	Male	38,046	20,722	54.5	6,227	16.4	2,399	6.3	1,172	3.1	752	2.0	6,774	17.8	<.0001
	Female	15,405	6,970	45.2	2,133	13.8	1,163	7.5	701	4.6	456	3.0	3,982	25.8	
Insurance Type															
	Health Insurance	48,586	24,839	51.1	7,695	15.8	3,256	6.7	1,734	3.6	1,088	2.2	9,974	20.5	<.0001
	Medical Aids	4,865	2,853	58.6	665	13.7	306	6.3	139	2.9	120	2.5	782	16.1	
Home-Oxygen Therapy															
	User	1,138	358	31.5	261	22.9	189	16.6	102	9.0	83	7.3	145	12.7	<.0001
	Non-User	52,313	27,334	52.3	8,099	15.5	3,373	6.4	1,771	3.4	1,125	2.2	10,611	20.3	
Respiratory Disability															
	Disabled	414	157	37.9	73	17.6	44	10.6	25	6.0	27	6.5	88	21.3	<.0001
	Non-disabled	53,037	27,535	51.9	8,287	15.6	3,518	6.6	1,848	3.5	1,181	2.2	10,668	20.1	
Diagnosed Year															
	2005	16,654	8,543	51.3	2,627	15.8	1,123	6.7	582	3.5	382	2.3	3,397	20.4	0.463
	2006	18,149	9,409	51.8	2,871	15.8	1,249	6.9	635	3.5	413	2.3	3,572	19.7	
	2007	18,648	9,740	52.2	2,862	15.3	1,190	6.4	656	3.5	413	2.2	3,787	20.3	

2. Healthcare spending and utilization of lung cancer patients

As noted in table 6, mean total spending was KRW 25,451,471 which composed of inpatient spending of KRW 18,338,230 and outpatient spending of KRW 7,113,241. In addition, nationwide lung cancer patients utilized average 56.0 days of inpatient services and 25.9 days of outpatient days in their 5 years of follow-up Table 6).

1) Spending and utilization by characteristics of patients

Table 10 presents total, inpatient, outpatient spending and inpatient, outpatient utilization by various patient characteristics. All spending and utilization were higher in age groups of 40-59. For example total spending of age group 40-49 was KRW 40,256,515 which was a lot higher than mean total spending (KRW 25,451,471). Inpatient spending (KRW 26,563,430), outpatient spending (KRW 13,693,085), inpatient LOS (72.8 days), and outpatient days (40.0 days) were also higher than mean spending and utilization.

Sex differences were also identified that male had more spending on total and inpatient but somewhat lower for outpatient spending. Inpatient LOS was longer for female. People who hold health insurance had higher total, inpatient, and outpatient spending (KRW 26,261,248, KRW 18,749,721, and KRW 7,511,527 respectively). Outpatient spending was especially two times higher than people who hold medical aids (KRW 7,511,527 for health insurance vs. KRW 3,135,620 for medical aides). Home Oxygen Therapy users and respiratory disabled

population had higher spending and utilization as well.

Lung cancer patients who diagnosed in 2007 had higher total spending (KRW 27,462,222), inpatient spending (KRW 19,670,472), outpatient spending (KRW 7,791,750), inpatient LOS (58.8 days), and outpatient days (26.1 days) than diagnosed year of 2005 and 2006. Lung cancer patient who died during 3-3.99 years after diagnosis had highest in spending and utilization which accounted for total spending of KRW 56,994,155, inpatient spending of KRW 34,431,861, outpatient spending of KRW 22,562,295, inpatient LOS of 107.8 days, and outpatient days of 66.0 days which accounted a lot higher than mean spending and utilization. 5 years survivors had relatively lower spending than mean spending and utilization which accounted for total spending of KRW 24,486,381, inpatient spending of KRW 14,727,775, outpatient spending of KRW 9,758,606, inpatient LOS of 39.2 days, and outpatient days of 40.9 days. Mean spending and utilization for patients who died within a year of diagnosis had somewhat lower spending and utilization which accounted for total spending of KRW 15,936,865, inpatient spending of KRW 13,855,150, outpatient spending of KRW 2,081,715, inpatient LOS of 44.4 days, and outpatient days of 9.0 days.

The results showed that patient who died during 1-5 years after diagnosis of lung cancer had much higher spending and utilization than mean spending and utilization, although 5 years survivors were relatively similar to the mean. This is because we have more than half of patient who died within a year after diagnosis of lung cancer and their spending and utilization is relatively lower than other groups due to their lower survival times.

Table 10. Spending and utilization by characteristics of nationwide 5 year follow-up lung cancer patient diagnosed during 2005-2007

		Total Spending		Inpatient Spending		Outpatient Spending		Inpatient LOS		Outpatient Days	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age Group											
	80-	8,829,025	10,462,344	7,750,721	9,040,450	1,078,303	3,371,445	38.3	62.7	7.1	15.0
	70-79	18,280,309	19,729,220	14,234,546	15,317,140	4,045,763	8,801,127	49.2	62.3	17.7	26.8
	60-69	29,304,826	25,951,356	20,927,218	19,282,011	8,377,608	13,422,664	58.3	64.6	31.2	36.0
	50-59	38,387,286	33,445,890	25,966,658	24,382,694	12,420,628	17,960,191	71.6	86.8	40.1	42.4
	40-49	40,256,515	37,814,866	26,563,430	27,171,684	13,693,085	20,079,753	72.8	96.0	40.0	41.6
	30-39	37,449,809	37,670,403	23,983,773	26,080,774	13,466,036	20,937,279	64.0	87.6	35.7	40.3
	20-29	23,642,281	29,095,710	17,085,836	22,074,358	6,556,445	12,151,207	44.7	57.8	21.6	31.4
	-19	22,957,857	37,645,690	17,144,067	25,875,712	5,813,790	20,054,405	58.4	139.7	17.7	28.6
Sex											
	Male	25,634,524	25,856,751	18,827,728	19,435,980	6,806,796	12,129,040	54.6	64.2	26.1	34.3
	Female	24,999,382	30,022,298	17,129,309	20,344,464	7,870,073	16,287,663	59.2	85.4	25.4	35.9
Insurance Type											
	Health Insurance	26,261,248	27,531,557	18,749,721	19,934,657	7,511,527	13,790,269	55.3	69.0	27.1	35.4
	Medical Aids	17,364,350	21,012,735	14,228,729	16,852,888	3,135,620	8,741,397	62.3	88.2	14.1	24.1
Home-Oxygen Therapy											
	User	44,213,803	36,614,213	28,229,403	27,003,477	15,984,400	20,867,394	80.6	97.8	47.4	44.5
	Non-User	25,043,321	26,735,117	18,123,060	19,472,825	6,920,261	13,195,927	55.4	70.2	25.4	34.3

Respiratory Disability										
Disabled	32,688,017	32,009,151	25,211,065	26,388,580	7,476,952	12,166,779	77.7	86.0	35.2	47.6
Non-disabled	25,394,983	27,075,384	18,284,581	19,646,825	7,110,402	13,478,213	55.8	70.9	25.8	34.6
Diagnosed Year										
2005	22,883,645	24,958,570	16,753,140	18,537,920	6,130,505	11,809,171	51.4	67.0	25.4	34.4
2006	25,741,740	27,485,463	18,423,879	19,704,136	7,317,861	13,839,963	57.2	71.5	26.1	34.7
2007	27,462,222	28,413,411	19,670,472	20,628,710	7,791,750	14,409,751	58.8	73.8	26.1	35.0
Death or F/U ends after Diagnosis										
Within a year	15,936,865	15,147,329	13,855,150	13,603,013	2,081,715	4,062,094	44.4	40.0	9.0	13.2
During 1-1.99 yrs	37,062,947	25,781,070	26,594,289	21,727,652	10,468,658	11,153,466	80.8	71.8	36.1	27.9
2-2.99 yrs	48,494,424	34,357,305	31,084,050	26,709,814	17,410,374	18,091,506	94.2	97.1	53.1	37.9
3-3.99 yrs	56,994,155	43,412,652	34,431,861	32,423,843	22,562,295	23,424,679	107.8	137.0	66.0	50.0
4-4.99 yrs	54,945,330	47,440,079	33,582,326	33,751,059	21,363,004	26,838,742	106.0	155.3	65.8	53.7
5 yrs Survivors	24,486,381	28,141,413	14,727,775	17,287,799	9,758,606	17,239,660	39.2	74.2	40.9	44.3

2) Spending and utilization by patients' time stages of lung cancer patients

Table 11 shows healthcare spending and utilization by patients' time stages of lung cancer and its percentage over episode spending and utilization. Relatively large portion of spending and utilization were occurred during first year of diagnosis and it is gradually decreased.

Table 11. Spending and utilization by time stage of nationwide 5 year follow-up lung cancer patients diagnosed during 2005-2007

	Mean	SD	% over Total
Total Spending	25,451,471	27,124,232	
First Year	17,433,075	15,647,295	68.5
Second Year	4,046,166	9,830,290	15.9
Third Year	2,009,032	7,119,801	7.9
Fourth Year	1,179,830	5,509,786	4.6
Firth Year	783,367	4,271,824	3.1
Inpatient Spending	18,338,230	19,716,931	
First Year	13,713,507	13,415,800	74.8
Second Year	2,415,270	7,324,551	13.2
Third Year	1,119,131	5,136,979	6.1
Fourth Year	664,619	4,115,162	3.6
Firth Year	425,703	3,150,757	2.3
Outpatient Spending	7,113,241	13,468,481	
First Year	3,719,568	6,049,480	52.3
Second Year	1,630,896	4,890,604	22.9
Third Year	889,901	3,777,989	12.5
Fourth Year	515,212	2,810,157	7.2
Firth Year	357,664	2,234,992	5.0
Inpatient LOS	56.0	71.0	
First Year	39.9	41.3	71.4
Second Year	8.2	26.9	14.7
Third Year	3.9	20.2	6.9
Fourth Year	2.4	16.9	4.2
Firth Year	1.6	13.8	2.8
Outpatient Days	25.9	34.7	
First Year	15.0	18.2	58.0
Second Year	5.0	10.7	19.5
Third Year	2.7	7.9	10.5
Fourth Year	1.8	6.3	6.9
Firth Year	1.3	5.7	5.2

For example, total spending of KRW 17,433,075 were spent during first year which accounted for 68.5% of total spending KRW 25,451,471. Then total spending had gradually decreased as KRW 4,046,166 in second year which accounted for 15.9% of

total spending. KRW 2,009,032, KRW 1,179,830, and KRW 783,367 were reported mean total spending of third, fourth, and firth year of total spending respectively which accounted for 7.9%, 4.6%, and 3.1% of total spending.

Inpatient spending of KRW 13,713,507 was spent during first year which accounted for 74.8% of total inpatient spending KRW 18,338,230. Then inpatient spending had gradually decreased as KRW 2,415,270 in second year which accounted for 13.2% of total inpatient spending. KRW 1,119,130, KRW 664,619, and KRW 425,703 were reported mean inpatient spending of third, fourth, and firth year of inpatient spending respectively which accounted for 6.1%, 3.6%, and 2.3% of total inpatient spending.

Outpatient spending of KRW 3,719,568 was spent during first year which accounted for 52.3% of total outpatient spending KRW 7,113,241. Then outpatient spending had gradually decreased as KRW 1,630,896 in second year which accounted for 22.9% of total outpatient spending. KRW 889,901, KRW 515,212, and KRW 357,664 were reported mean outpatient spending of third, fourth, and firth year of outpatient spending respectively which accounted for 12.5%, 7.2%, and 5.0% of total outpatient spending.

Inpatient utilization of 39.9 days was spent during first year which accounted for 71.4% of total inpatient utilization 56.0 days. Then inpatient utilization had gradually decreased as 8.2 days in second year which accounted for 14.7% of total inpatient days. 3.9 days, 2.4 days, and 1.6 days were reported mean inpatient utilization of third, fourth, and firth year of inpatient utilization respectively which accounted for 6.9%, 4.2%, and 2.8% of total inpatient utilization.

Outpatient utilization of 15.0 days was spent during first year which accounted for 58.0% of total outpatient utilization 25.9 days. Then outpatient utilization had gradually decreased as 5.0 days in second year which accounted for 19.5% of total

outpatient days. 2.7 days, 1.8 days, and 1.3 days were reported mean outpatient utilization of third, fourth, and firth year of outpatient utilization respectively which accounted for 10.5%, 6.9%, and 5.2% of total inpatient utilization.

Table 11 and Table 12 shows that spending and utilization by time stage and duration of diagnosis to death of nationwide 5 year follow-up lung cancer patient diagnosed during 2005-2007 and percentage over total spending and utilization by time stage and duration of diagnosis to death of nationwide 5 year follow-up lung cancer patient diagnosed during 2005-2007.

Lung cancer patients who died within a year of diagnosis, of course, had all of their spending and utilization in first year only. Patients who died during 1-1.99 years after lung cancer diagnosis had first year spending of KRW 25,441,399 and KRW 11,621,448 in second year which accounted for 68.6% and 31.4% over total spending respectively. They also had first year inpatient spending of KRW 17,666,500 and KRW 89,927,790 in second year which accounted for 66.4% and 33.6% over total inpatient spending. First year of outpatient spending of KRW 7,774,899 and KRW 2,693,758 in second year also identified which accounted for 74.3% and 25.7% over total outpatient spending. They also had first year inpatient utilization of 49.4 days and 31.4 days in second year which accounted for 61.2% and 38.8% over total inpatient utilization. First year of outpatient utilization of 27.4 days and 8.8 days in second year also identified which accounted for 75.8% and 24.2% over total outpatient utilization. Lung cancer patients who categorized into others, depending on duration of diagnosis to death, had relatively similar trend as patients presented above that lung cancer patient had significant portion of spending and utilization within very first year of their lung cancer time frame, then the portion gradually decreased. All others had similar trend but 5 years survivors.

Table 12. Spending and utilization by time stage and duration of diagnosis to death of nationwide 5 year follow-up lung cancer patient diagnosed during 2005-2007

		Duration of diagnosis to death or follow-up end											
		Within a year		During 1-1.99 yrs		During 2-2.99 yrs		During 3-3.99 yrs		During 4-4.99 yrs		5 yrs Survivors	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	First Year	15,936,865	15,147,329	25,441,399	18,584,195.0	20,577,473	15,614,808.4	19,245,118	15,048,269.7	16,094,304	13,690,352.3	13,854,271	11,998,449.7
	Second Year			11,621,548	13,470,536.1	16,721,318	17,078,777.7	11,133,191	14,005,287.8	7,366,263	11,697,671.0	2,770,847	6,447,111.0
Total Spending	Third Year					11,195,632	13,090,936.0	15,562,364	17,222,489.2	8,930,688	13,225,812.7	2,563,160	6,690,725.0
	Fourth Year							11,053,483	14,017,790.5	12,504,727	16,407,655.6	2,533,863	6,936,309.4
	Firth Year									10,049,349	12,898,199.4	2,764,240	7,489,025.6
	First Year	13,855,150	13,603,013	17,666,500	16,121,210.9	13,553,196	13,005,643.7	12,897,832	12,516,084.4	11,394,708	11,212,735.8	10,731,962	9,841,636.6
	Second Year			8,927,790	11,588,713.5	8,947,290	13,373,532.5	4,430,271	9,272,028.7	3,168,813	7,826,720.8	973,058	4,027,108.3
Inpatient Spending	Third Year					8,583,564	11,181,843.2	8,151,208	13,656,320.9	3,613,074	8,644,196.9	893,662	4,109,319.1
	Fourth Year							8,952,549	12,752,303.7	7,279,217	12,825,149.2	926,284	4,338,621.0
	Firth Year									8,126,515	11,458,486.1	1,202,810	5,161,150.2
	First Year	2,081,715	4,062,094	7,774,899	8,384,907.1	7,024,277	8,111,162.5	6,347,285	7,553,974.8	4,699,596	6,579,725.3	3,122,310	4,816,443.1
	Second Year			2,693,758	4,850,720.3	7,774,029	9,979,043.1	6,702,920	9,836,173.0	4,197,450	7,888,669.0	1,797,790	4,279,109.1
Outpatient Spending	Third Year					2,612,068	4,957,386.4	7,411,156	9,994,854.6	5,317,614	9,522,610.9	1,669,498	4,623,862.7
	Fourth Year							2,100,934	4,023,370.1	5,225,510	8,716,787.7	1,607,579	4,774,978.4
	Firth Year									1,922,833	3,958,117.6	1,561,430	4,566,067.0
	First Year	44.4	40	49.4	52.9	34.3	41.8	32.5	39.7	28.1	34.9	25.6	28.4
	Second Year			31.4	39.5	29.5	52.1	13.8	40.4	10.0	34.2	3.1	17.0
Inpatient Days	Third Year					30.4	39.7	29.0	59.2	11.9	41.3	2.8	17.2
	Fourth Year							32.5	47.2	26.5	57.2	3.2	20.6
	Firth Year									29.4	44.3	4.5	24.9
	First Year	9.0	13	27.4	21.6	24.8	20.7	23.9	21.0	19.5	19.1	15.6	17.6
	Second Year			8.8	12.2	19.9	17.2	16.6	16.4	11.7	12.2	7.4	10.3
Outpatient Days	Third Year					8.3	11.6	18.1	18.6	12.7	14.0	6.2	9.0
	Fourth Year							7.4	10.7	14.8	17.0	5.9	9.7
	Firth Year									7.0	10.6	5.9	10.9

Table 13. % over total spending and utilization by time stage and duration of diagnosis to death of nationwide 5 year follow-up lung cancer patient diagnosed during 2005-2007

		% over each spending and utilization by time frame and duration of diagnosis to death or follow-up end					
		Within a year	**During 1-1.99 yrs**	**During 2-2.99 yrs**	**During 3-3.99 yrs**	**During 4-4.99 yrs**	**5 yrs Survivors**
Total Spending	First Year	100	68.6	42.4	33.8	29.3	56.6
	Second Year		31.4	34.5	19.5	13.4	11.3
	Third Year			23.1	27.3	16.3	10.5
	Fourth Year				19.4	22.8	10.3
	Firth Year					18.3	11.3
Inpatient Spending	First Year	100	66.4	43.6	37.4	33.9	72.8
	Second Year		33.6	28.8	12.9	9.4	6.6
	Third Year			27.6	23.7	10.8	6.1
	Fourth Year				26.0	21.7	6.3
	Firth Year					24.2	8.2
Outpatient Spending	First Year	100	74.3	40.4	28.1	22.0	31.9
	Second Year		25.7	44.6	29.7	19.6	18.5
	Third Year			15.0	32.8	24.9	17.1
	Fourth Year				9.3	24.5	16.5
	Firth Year					9.0	16.0
Inpatient Days	First Year	100	61.2	36.4	30.1	26.5	65.1
	Second Year		38.8	31.3	12.8	9.5	8.0
	Third Year			32.3	26.9	11.2	7.3
	Fourth Year				30.1	25.1	8.1
	Firth Year					27.8	11.4
Outpatient Days	First Year	100	75.8	46.8	36.2	29.6	38.0
	Second Year		24.2	37.6	25.2	17.8	18.2
	Third Year			15.6	27.4	19.4	15.0
	Fourth Year				11.2	22.5	14.4
	Firth Year					10.7	14.5

5 years survivals had somewhat different trend that their spending and utilization had u-shape that the spending and utilization somewhat increased in firth year of their lung cancer time stage. They had first year spending of KRW 13,854,271 and KRW 2,770,847 in second year, KRW 2,563,160 in third year, KRW 2,533,863 in fourth year, and KRW 2,764,240 in firth year which accounted for 56.6%, 11.3%, 10.5%, 10.3%, and 11.3% over total spending respectively. As noted firth year spending was slightly increased in total spending. They also had first year inpatient spending of KRW 10,731,962, KRW 973,058 in second year, KRW 893,662 in third year, KRW 926,284 in fourth year, and KRW 1,202,810 in firth year which accounted for 72.8%, 6.6%, 6.1%, 6.3%, 8.2% over total inpatient spending respectively. First year of outpatient spending of KRW 3,122,310, KRW 1,797,790 in second year, KRW 1,669,498 in third year, KRW 1,607,579 in fourth year, and KRW 1,561,430 in firth year which accounted for 31.9%, 18.5%, 17.1%, 16.5%, and 16.0% over total outpatient spending.

They also had first year inpatient utilization of 25.6 days, 3.1 days in second year, 2.8 days in third year, 3.2 days in fourth year, and 4.5 days in firth year which accounted for 65.1%, 8.0%, 7.3%, 8.1%, and 11.4% respectively over total inpatient utilization. First year of outpatient utilization of 15.6 days, 7.4 days in second year, 6.2 days in third year, 5.9 days in fourth year, and 5.9 days in forth year also identified which accounted for 38.0%, 18.2%, 15.0%, 14.4%, and 14.5% over total outpatient utilization. As noted firth year spending and utilization increased as u-shape. The figure 4 (Spending of 5 years survivors by time stage) and figure 5 (Utilization of 5 years survivors by time stage) shows the trend of these u-shape. The incremental, however, was not significant.

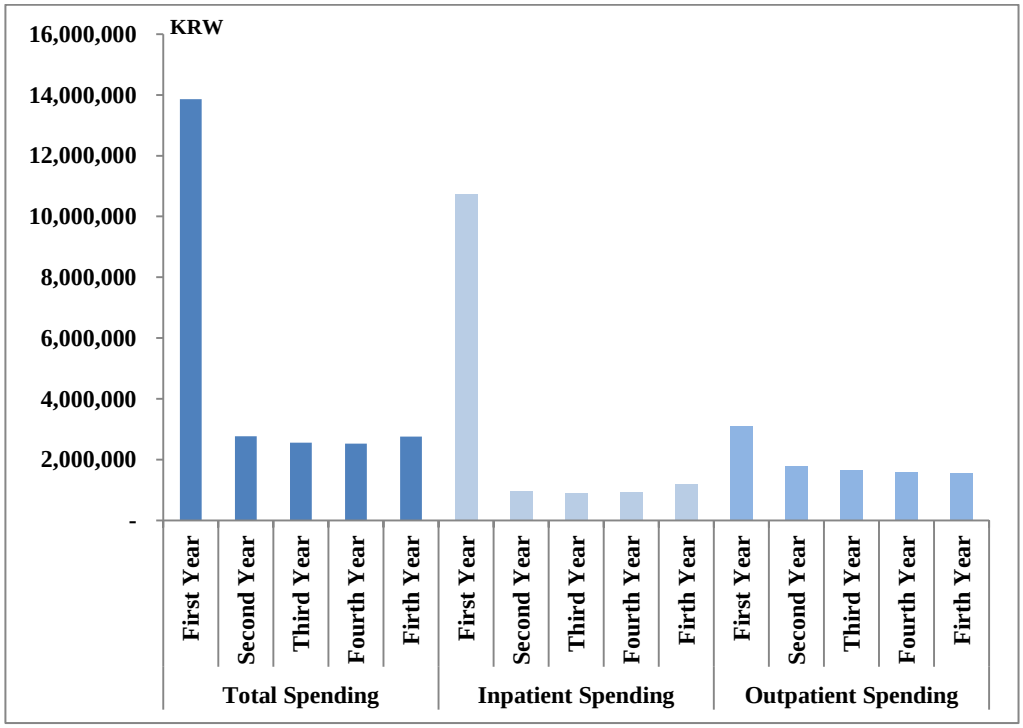

Figure 5. Healthcare spending of 5 years survivors by time stage

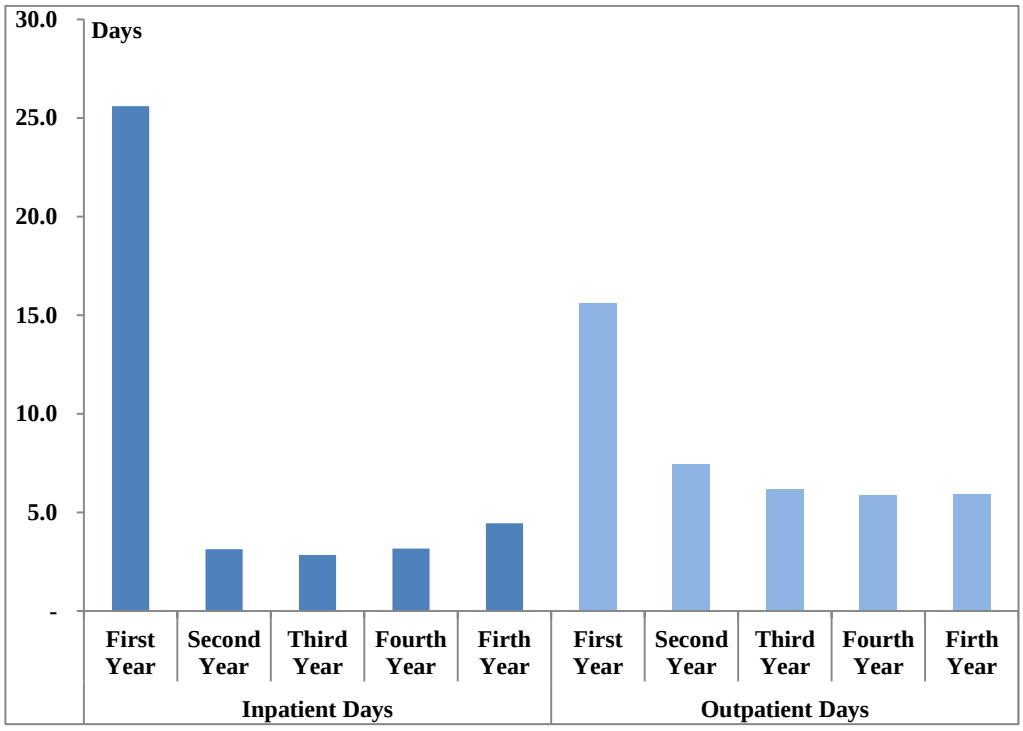

Figure 6. Healthcare utilization of 5 years survivors by time stage

3) Spending and utilization by periods before death and after diagnosis of lung cancer patients

Table 14 depicts healthcare spending and utilization of 5 year follow-up lung cancer patients diagnosed during 2005-2007 by periods before follow-up ends. Real spending and utilization, and its percentage over episode are presented. Inpatient spending during last three months before follow-up end was KRW 6,398,464 which was accounted for 34.9% of total inpatient spending. Inpatient spending during last six months and twelve months before follow-up end were KRW 9,107,200 and KRW 11,989,903 which accounted for 49.7% and 65.4% of total inpatient spending respectively. Inpatient LOS during last months before follow-up ends were also constituted large portions that 32.9%, 55.3%, and 70.7% for last 3, 6, 12 months before follow-up end respectively.

Table 14. Healthcare spending and utilization of lung cancer patients by periods before follow-up end

		Mean	SD	% over Total
Inpatient Spending during	**Last 3 months**	6,398,464	8,103,822	34.9
	Last 6 months	9,107,200	11,094,390	49.7
	Last 12 months	11,989,903	14,448,729	65.4
Outpatient Spending during	**Last 3 months**	753,572	1,600,079	10.6
	Last 6 months	1,718,097	3,248,743	24.2
	Last 12 months	3,230,939	5,986,534	45.4
Inpatient LOS during	**Last 3 months**	21.9	23.7	39.2
	Last 6 months	31.0	35.4	55.3
	Last 12 months	39.5	48.2	70.7
Outpatient Days during	**Last 3 months**	3.3	5.3	12.9
	Last 6 months	6.7	9.5	26.0
	Last 12 months	11.6	15.8	44.8

Outpatient spending during last three months before follow-up end was KRW 753,572 which was accounted for 10.6% of total outpatient spending. Outpatient spending during last six months and twelve months before follow-up end were KRW 1,718,097 and KRW 3,230,939 which accounted for 24.2% and 45.4% of total outpatient spending respectively. Outpatient days during last months before follow-up ends were also constituted relatively large portions that 12.9%, 26.0%, and 44.8% for last 3, 6, 12 months before follow-up end respectively.

Table 15 depicts healthcare spending and utilization of 5 year follow-up lung cancer patients diagnosed during 2005-2007 by periods after diagnosis of lung cancer. Real spending and utilization, and its percentage over episode are also presented. Inpatient spending during first three months after diagnosis was KRW 8,897,402 which was accounted for 48.5% of total inpatient spending. Inpatient spending during first six months and twelve months after lung cancer diagnosis were KRW 11,283,409 and KRW 13,713,507 which accounted for 61.5% and 74.8% of total inpatient spending respectively. Inpatient LOS during first months after diagnosis of lung cancer were also constituted large portions that 44.0% (24.6 days), 56.9% (31.9 days), and 71.4% (39.9 days) for last 3, 6, 12 months after diagnosis respectively.

Outpatient spending during first three months after diagnosis was KRW 1,484,083 which was accounted for 20.9% of total inpatient spending. Outpatient spending during first six months and twelve months after lung cancer diagnosis were KRW 2,417,594 and KRW 3,719,568 which accounted for 34.0% and 52.3% of total outpatient spending respectively. Outpatient days during first months after diagnosis of lung cancer were also constituted relative large portions that 24.8% (6.4 days), 40.0% (10.3 days), and 58.0% (15.0 days) for last 3, 6, 12 months after

diagnosis respectively. Outpatient spending and utilization were somewhat lower portions than inpatient spending and utilization, however, it is still high.

Table 15. Healthcare spending and utilization of lung cancer patients by periods after diagnosis

		Mean	SD	% over Total
Inpatient Spending during	**First 3 months**	8,897,402	8,169,473	48.5
	First 6 months	11,283,409	10,651,880	61.5
	First 12 months	13,713,507	13,415,800	74.8
Outpatient Spending during	**First 3 months**	1,484,083	2,599,499	20.9
	First 6 months	2,417,594	3,917,932	34.0
	First 12 months	3,719,568	6,049,480	52.3
Inpatient LOS during	**First 3 months**	24.6	22.4	44.0
	First 6 months	31.9	30.9	56.9
	First 12 months	39.9	41.3	71.4
Outpatient Days during	**First 3 months**	6.4	8.7	24.8
	First 6 months	10.3	12.9	40.0
	First 12 months	15.0	18.2	58.0

Throughout the table 16 to table 19, the results of healthcare spending and utilization of lung cancer patients by periods before follow-up end and duration of diagnosis to death, healthcare spending and utilization of lung cancer patients by periods after diagnosis and duration of diagnosis to death, % over total healthcare spending and utilization of lung cancer patients by periods before follow-up end and duration of diagnosis to death, and % over healthcare spending and utilization of lung cancer patients by periods after diagnosis and duration of diagnosis to death were presented. Except 5 year survivors, most of lung cancer patient had significant portion of spending and utilization during last stage of their lung cancer. However, all types of patient had relatively large amount of spending and utilization within very first time stage of their lung cancer.

Table 16. Healthcare spending and utilization of lung cancer patients by periods before follow-up end and duration of diagnosis to death

		Duration of diagnosis to death or follow-up end								
		Within a year		Within a year	During 1-1.99 yrs		% over Total	During 2-2.99 yrs		% over Total
		Mean	SD		Mean	SD		Mean	SD	
Inpatient Spending during	Last 3 months	8,090,501	8,330,863	44.1	7,325,015	8,004,217	39.9	7,396,996	8,320,697	40.3
	Last 6 months	11,251,413	11,041,639	61.4	11,022,871	11,585,295	60.1	10,751,468	11,830,481	58.6
	Last 12 months	13,855,150	13,603,013	75.6	16,751,373	16,486,674	91.3	15,021,792	16,093,404	81.9
Outpatient Spending during	Last 3 months	748,863	1,543,839	10.5	1,216,753	1,982,936	17.1	1,109,334	1,913,235	15.6
	Last 6 months	1,499,120	2,865,003	21.1	3,183,464	4,234,299	44.8	2,945,758	4,233,778	41.4
	Last 12 months	2,081,715	4,062,094	29.3	7,066,346	8,136,667	99.3	7,056,826	8,770,198	99.2
Inpatient LOS during	Last 3 months	27.2	22.5	48.6	26.2	24.7	46.9	26.2	25.6	46.9
	Last 6 months	37.2	32.5	66.4	39.1	39.2	69.9	38.1	40.0	68.0
	Last 12 months	44.4	40.0	79.3	55.6	57.5	99.4	52.1	59.9	93.2
Outpatient Days during	Last 3 months	3.6	5.6	14.0	4.7	5.6	18.0	4.4	5.7	17.1
	Last 6 months	6.7	9.5	25.8	10.7	10.5	41.4	9.9	10.3	38.1
	Last 12 months	9.0	13.2	34.7	23.3	19.4	89.9	20.1	17.6	77.5
		During 3-3.99 yrs		% over Total	During 4-4.99 yrs		% over Total	5 yrs Survivors		% over Total
		Mean	SD		Mean	SD		Mean	SD	
Inpatient Spending during	Last 3 months	7,417,062	8,850,793	40.4	6,575,512	8,494,179	35.9	794,118	3,642,307	4.3
	Last 6 months	10,734,628	12,984,551	58.5	9,382,381	11,542,194	51.2	1,239,027	4,987,924	6.8
	Last 12 months	14,715,106	17,462,675	80.2	12,806,285	15,943,524	69.8	1,916,604	7,071,027	10.5
Outpatient Spending during	Last 3 months	920,864	1,691,287	12.9	757,331	1,417,744	10.6	258,323	1,066,215	3.6
	Last 6 months	2,436,642	3,679,912	34.3	2,055,523	3,302,842	28.9	573,346	2,040,239	8.1
	Last 12 months	6,157,403	8,125,412	86.6	4,733,958	7,203,526	66.6	1,263,255	4,010,841	17.8
Inpatient LOS during	Last 3 months	25.6	26.6	45.8	23.2	25.9	41.4	2.9	12.0	5.1
	Last 6 months	38.4	44.0	68.6	34.4	42.3	61.5	4.7	19.7	8.4
	Last 12 months	52.6	67.7	94.0	47.0	65.6	83.9	7.3	31.6	13.1
Outpatient Days during	Last 3 months	3.7	5.2	14.3	3.7	5.3	14.2	1.1	3.0	4.2
	Last 6 months	8.5	9.6	32.8	7.9	9.8	30.4	2.3	5.6	9.1
	Last 12 months	17.8	18.7	68.9	15.5	16.9	59.8	4.9	10.6	18.8

Table 17. Healthcare spending and utilization of lung cancer patients by periods after diagnosis and duration of diagnosis to death

		Duration of diagnosis to death or follow-up end								
		Within a year		% over Total	During 1-1.99 yrs		% over Total	During 2-2.99 yrs		% over Total
		Mean	SD		Mean	SD		Mean	SD	
Inpatient Spending during	First 3 months	9,224,051	8,935,073	50.3	8,598,118	7,481,783	46.9	8,402,078	7,536,005	45.8
	First 6 months	11,840,154	11,483,829	64.6	11,682,793	10,633,985	63.7	10,774,866	9,892,513	58.8
	First 12 months	13,855,150	13,603,013	75.6	17,666,500	16,121,211	96.3	13,553,196	13,005,644	73.9
Outpatient Spending during	First 3 months	1,108,077	2,172,835	15.6	2,262,737	3,097,518	31.8	2,325,756	3,242,897	32.7
	First 6 months	1,713,307	3,247,639	24.1	4,043,031	4,802,731	56.8	3,965,044	4,927,379	55.7
	First 12 months	2,081,715	4,062,094	29.3	7,774,899	8,384,907	99.3	7,024,277	8,111,163	98.7
Inpatient LOS during	First 3 months	28.4	24.6	50.7	21.8	20.6	39.0	20.4	19.5	36.5
	First 6 months	37.3	33.3	66.7	29.8	30.5	53.3	26.5	28.5	47.3
	First 12 months	44.4	40.0	79.3	49.4	52.9	88.4	34.3	41.8	61.3
Outpatient Days during	First 3 months	5.0	7.4	19.3	8.9	9.8	34.5	8.9	10.0	34.3
	First 6 months	7.5	10.8	29.1	15.6	14.3	60.2	15.2	14.7	58.7
	First 12 months	9.0	13.2	34.7	27.4	21.6	95.8	24.8	20.7	95.9
		During 3-3.99 yrs		% over Total	During 4-4.99 yrs		% over Total	5 yrs Survivors		% over Total
		Mean	SD		Mean	SD		Mean	SD	
Inpatient Spending during	First 3 months	8,553,571	7,413,067	46.6	8,229,997	7,698,955	44.9	8,587,904	6,856,519	46.8
	First 6 months	10,878,640	9,983,356	59.3	10,129,789	9,701,658	55.2	9,908,074	8,547,258	54.0
	First 12 months	12,897,832	12,516,084	70.3	11,394,708	11,212,736	62.1	10,731,962	9,841,637	58.5
Outpatient Spending during	First 3 months	2,273,093	3,197,878	32.0	1,897,148	3,128,761	26.7	1,384,412	2,530,188	19.5
	First 6 months	3,840,495	4,871,859	54.0	3,005,927	4,415,232	42.3	2,141,158	3,500,568	30.1
	First 12 months	6,347,285	7,553,975	89.2	4,699,596	6,579,725	66.1	3,122,310	4,816,443	43.9
Inpatient LOS during	First 3 months	20.6	18.7	36.8	19.4	18.7	34.7	19.7	17.4	35.2
	First 6 months	26.1	27.4	46.7	24.1	25.6	43.1	23.1	22.8	41.2
	First 12 months	32.5	39.7	58.0	28.1	34.9	50.3	25.6	28.4	45.7
Outpatient Days during	First 3 months	9.0	10.4	34.7	8.0	10.3	30.7	6.8	9.3	26.1
	First 6 months	15.4	15.7	59.7	12.8	14.2	49.6	10.7	13.2	41.5
	First 12 months	23.9	21.0	92.3	19.5	19.1	75.4	15.6	17.6	60.2

Table 18. % over total healthcare spending and utilization of lung cancer patients by periods before follow-up end and duration of diagnosis to death

		Mean	Within a year	1-1.99 yrs	2-2.99 yrs	3-3.99 yrs	4-4.99 yrs	5 yrs Survivors
Inpatient Spending during	Last 3 months	34.9	44.1	39.9	40.3	40.4	35.9	4.3
	Last 6 months	49.7	61.4	60.1	58.6	58.5	51.2	6.8
	Last 12 months	65.4	75.6	91.3	81.9	80.2	69.8	10.5
Outpatient Spending during	Last 3 months	10.6	10.5	17.1	15.6	12.9	10.6	3.6
	Last 6 months	24.2	21.1	44.8	41.4	34.3	28.9	8.1
	Last 12 months	45.4	29.3	99.3	99.2	86.6	66.6	17.8
Inpatient LOS during	Last 3 months	39.2	48.6	46.9	46.9	45.8	41.4	5.1
	Last 6 months	55.3	66.4	69.9	68.0	68.6	61.5	8.4
	Last 12 months	70.7	79.3	99.4	93.2	94.0	83.9	13.1
Outpatient Days during	Last 3 months	12.9	14.0	18.0	17.1	14.3	14.2	4.2
	Last 6 months	26.0	25.8	41.4	38.1	32.8	30.4	9.1
	Last 12 months	44.8	34.7	89.9	77.5	68.9	59.8	18.8

Table 19. % over healthcare spending and utilization of lung cancer patients by periods after diagnosis and duration of diagnosis to death

		Mean	Within a year	1-1.99 yrs	2-2.99 yrs	3-3.99 yrs	4-4.99 yrs	5 yrs Survivors
Inpatient Spending during	First 3 months	48.5	50.3	46.9	45.8	46.6	44.9	46.8
	First 6 months	61.5	64.6	63.7	58.8	59.3	55.2	54.0
	First 12 months	74.8	75.6	96.3	73.9	70.3	62.1	58.5
Outpatient Spending during	First 3 months	20.9	15.6	31.8	32.7	32.0	26.7	19.5
	First 6 months	34.0	24.1	56.8	55.7	54.0	42.3	30.1
	First 12 months	52.3	29.3	99.3	98.7	89.2	66.1	43.9
Inpatient LOS during	First 3 months	44.0	50.7	39.0	36.5	36.8	34.7	35.2
	First 6 months	56.9	66.7	53.3	47.3	46.7	43.1	41.2
	First 12 months	71.4	79.3	88.4	61.3	58.0	50.3	45.7
Outpatient Days during	First 3 months	24.8	19.3	34.5	34.3	34.7	30.7	26.1
	First 6 months	40.0	29.1	60.2	58.7	59.7	49.6	41.5
	First 12 months	58.0	34.7	95.8	95.9	92.3	75.4	60.2

3. Multivariate Analysis: Cox Proportional Hazard Model

As shown in table 20, this study assessed the association between patient characteristics and their survival probability using Cox proportional hazard models after adjusting for all other covariates. This study found that no differences on hazard ratios by insurance type (Health insurance Vs. Medical aids) and diagnosed year, however, found significant differences among sex (Male Vs. Female), and age-group (higher in older than 30).

Table 20. Cox-Proportional Hazard model for 5 years follow-up or dead lung cancer patients by their different types of characteristics

		Hazard Ratio	95% HR CI		Pr > ChiSq
Age Group					
	80-	6.63	4.17	10.53	<.0001
	70-79	4.34	2.74	6.90	<.0001
	60-69	2.96	1.86	4.69	<.0001
	50-59	2.27	1.43	3.60	<.0001
	40-49	2.02	1.27	3.21	0.003
	30-39	2.03	1.27	3.25	0.003
	20-29	1.59	0.95	2.67	0.077
	-19	1.00			
Sex					
	Female	0.74	0.73	0.76	<.0001
	Male	1.00			
Insurance Type					
	Health Insurance	0.99	0.96	1.02	0.489
	Medical Aids	1.00			
Diagnosed Year					
	2005	0.99	0.97	1.02	0.710
	2006	1.01	0.99	1.04	0.301
	2007	1.00			
Home-Oxygen Therapy					
	Non-User	1.05	0.99	1.12	0.116
	User	1.00			
Respiratory Disability					
	Disabled	0.83	0.74	0.93	<.0001
	Non-disabled	1.00			
ICU Days		1.01	1.01	1.01	<.0001
Ventilator Days		1.00	1.00	1.00	0.552

Hazard ratio of age was somewhat greater in older age group strata, but no differences were found in 20-29 as compared to less than 19 (P=0.077). Hazard ratios were gradually increased as patient's diagnosed age getting older (highest in age 80+, HR=6.63, P<0.001). Sex differences also found that female had greater survivals than male (HR=0.74, P<0.001). Respiratory disabled had greater survival than their counter parts; however, home-oxygen therapy users had indifferent survival probability than non-home-oxygen therapy users (P=0.116). Hazard ratio by diagnosis year of lung cancer showed also had non-significant association (year 2005 HR=0.99, P=0.0.710; year 2006 HR=1.01, P=0.301). Associations with individual utilization factor ICU days (HR=1.01), with survival of lung cancer patients was statistically significant, however, the effect was minimal. Ventilator days were not statistically significant with survival of lung cancer patients (P=0.552).

Both unadjusted Kaplan Meier curves and figures of adjusted Cox-proportional hazard models to investigate association between individual factors and survival among lung cancer patients were also included in the appendix.

4. Multivariate Analysis: Linear Mixed Models

Table 21 shows results of linear mixed models for association of various spending measures with individual and hospital level factors. Results of total spending by different age group strata showed that age with 80+ group had indifferent total spending as compared to less than 19 age group. Total spending was greatest in 50-59 (61.0%) and very high in other mid-age groups (51.8% in 60-69, 50.1% in 40-49). Inpatient spending and outpatient spending had also similar trends by age group strata that indifferent inpatient and outpatient spending found among age group more than 80 and age of 20-29 groups. The highest inpatient and outpatient spending also found in age group of 50-59 (47.8% greater), following 40-49 (inpatient: 38.3%, outpatient: 81.8%) and 60-69 (inpatient: 71.9%, outpatient: 72.1%). Male was also associated with higher spending (total spending was 5.6%, inpatient spending was 5.4%, and outpatient spending was 9.3%) than its counterpart, female group. Health insurance holders had higher total spending of 2.9% than medical aids population but their inpatient spending was 2.8% lower although their outpatient spending 44.2% higher.

Results for duration of diagnosis to death of lung cancer patients showed that patients who died during 1-3.99 years after lung cancer diagnosis had higher total spending (54.0%, 52.5%, and 43.5% respectively than 5 year survivors). Patient who died within a year of diagnosis had higher total spending but the amount was not very higher comparing to other groups. Inpatient spending also had similar trend, however, spending of patient who died within a year had relatively higher spending than 5 years survivors. Total spending of patient who died within a year of diagnosis was not very high because of relatively very low outpatient spending among the group (118.1% less spending than 5 years survivors). Other groups for outpatient spending were

relative similar to total spending.

Patients' diagnosed year was also associated with total, inpatient, and outpatient spending that patient who diagnosed in 2005 had 22.9% lower and 9.3% lower for 2006 diagnosed patient comparing to 2007 diagnosed patients. Inpatient and outpatient spending also had identical results. Home-oxygen therapy users had higher total (18.1%), inpatient (11.3%), and outpatient (30.4%) spending than non-users which all were statistically significant. Patient who received respiratory disability grading had both higher inpatient (10.3%) and outpatient (21.9%) spending, however, their total spending was not significantly different (3.2%, P=0.450)

Other individual factors such as ICU days, ventilator days had also statistically significant spending increase as ICU days and ventilator days were increase but the effect was very minimal. However, repeated numbers of inpatient admissions were associated with higher total spending (8.2%), inpatient spending (8.6%), and outpatient spending (7.0%) as well.

Although hospital structural variables (# of 100 Beds, Nurses per 100 beds, # of Specialist physician) were not statistically significant in order to determine total spending, inpatient spending, and outpatient spending, hospital type and hospital teaching status had statistically significant effect on the dependent variables. Teaching hospitals had higher total spending (35.6%), inpatient spending (32.8%), and outpatient spending (33.3%) which was all statistically significant. Large hospitals also had higher total spending (12.7%), inpatient spending (14.2%), and outpatient spending (4.4%) so as tertiary hospitals total spending (27.6%), inpatient spending (33.7%), and outpatient spending (16.1%) which was also statistically significant.

Table 21. Results of linear mixed models for association of spending with individual and hospital factors

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	-0.040	0.745	-0.043	0.709	-0.283	0.294
	70-79	0.280	0.021	0.232	0.045	0.276	0.303
	60-69	0.518	<.0001	0.419	0.000	0.721	0.007
	50-59	0.610	<.0001	0.478	<.0001	0.905	0.001
	40-49	0.501	<.0001	0.383	0.001	0.818	0.002
	30-39	0.432	0.001	0.307	0.010	0.768	<.0001
	20-29	0.213	0.132	0.222	0.102	0.239	0.441
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	0.056	<.0001	0.054	<.0001	0.093	<.0001
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.029	0.036	-0.028	0.039	0.442	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	0.085	<.0001	0.258	<.0001	-1.181	<.0001
	During 1-1.99 yrs	0.435	<.0001	0.400	<.0001	0.071	0.003
	2-2.99 yrs	0.525	<.0001	0.385	<.0001	0.387	<.0001
	3-3.99 yrs	0.540	<.0001	0.343	<.0001	0.528	<.0001
	4-4.99 yrs	0.388	<.0001	0.246	<.0001	0.337	<.0001
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.229	<.0001	-0.193	<.0001	-0.240	<.0001
	2006	-0.093	<.0001	-0.085	<.0001	-0.052	0.004
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.181	<.0001	0.113	<.0001	0.304	<.0001
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.032	0.450	0.103	0.012	0.219	0.009
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.024	<.0001	0.026	<.0001	-0.003	0.060
Ventilator Days		0.003	0.001	0.005	<.0001	0.001	0.618
Number of Inpatient admissions		0.082	<.0001	0.086	<.0001	0.070	<.0001
Teaching Status							
	Teaching	0.356	<.0001	0.328	<.0001	0.333	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.276	<.0001	0.337	<.0001	0.161	0.177
	Large	0.127	<.0001	0.142	<.0001	0.044	0.552
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.009	0.457	0.020	0.100	0.000	0.999
Nurses per 100 beds		0.037	0.029	0.024	0.134	0.048	0.034
# of Specialist physician		0.0004	0.394	0.0001	0.833	0.0008	0.231
ICC		10.03%		10.00%		5.56%	

This study also examined ICC (intra-class correlation) in order to investigate reliability of multi-level modeling and the spending measure models showed that relatively higher ICC figures (10.03% for total spending, 10.00% for inpatient spending, and 5.56% for outpatient spending) that present significant portion of spending measures explained by hospital level factors.

Table 22 shows results of linear mixed models for association of utilization measures with individual and hospital level factors. Results of inpatient utilization by different age group strata showed that age with 80+ group, age group of 20-29, and age group of 30-39 had indifferent inpatient LOS as compared to less than 19 of age group. Inpatient LOS was greatest in 50-59 (34.0%) and very high in other mid-age groups (25.0% in 70-79, 31.5% in 60-69, and 24.8% in 40-49). Outpatient utilization had also similar trends by age group strata that indifferent outpatient utilization found among age group more than 80 (P=0.397) and age of 20-29 group (P=0.324). The highest outpatient utilization also found in age group of 50-59 (65.8% greater), following age group of 60-69 (60.2%) and 40-49 (54.5%). Male was also associated with higher outpatient utilization (8.6%) than its counterpart, female group, however inpatient LOS was lower for male population (3.1% less, P<0.001). Health insurance holders had lower inpatient utilization of 16.9% than medical aids population but their outpatient utilization was 23.8% greater.

Results for duration of diagnosis to death of lung cancer patients showed that patients who died had higher inpatient utilization (45.3%, 59.3%, 53.9%, 49.2%, 36.0% for duration of diagnosis to death within a year, during 1-2 years, during 2-3 years, during 3-4 years, during 4-5 years respectively) compared to 5 years survivors. Outpatient utilization was somewhat similar trend among patient who died during 2-5 years of lung cancer diagnosis (11.2%, 23.7%, and 16.8% for duration of diagnosis to

death during 2-3 years, during 3-4 years, during 4-5 years respectively), however, inverse relationship also found that patient who died within a year of diagnosis to death (117.1% lower) and during 1-2 years (16.4% lower).

Patients' diagnosed year was also associated with inpatient utilization that patient who diagnosed in 2005 had 11.4% lower and 2.7% lower for 2006 diagnosed patient comparing to 2007 diagnosed patients. Outpatient utilization results showed that patient who diagnosed in 2005 had 2.4% lower and 2.2 higher 2006 diagnosed patient comparing to 2007 diagnosed patients, however, those results were not statistically significant. (P=0.059 and P=0.079). Home-oxygen therapy users had higher inpatient (13.1%) and outpatient (21.5%) utilization than non-users which all were statistically significant. Patient who received respiratory disability grading had higher inpatient utilization (19.4%), but lower outpatient utilization, however, this was not significantly different (1.5%, P=0.791). Other individual factors such as ICU days, ventilator days had mixed results for inpatient utilization measures but the effect was very minimal. Outpatient utilization for such factors was not statistically significant. However, repeated numbers of inpatient admissions were associated with higher inpatient utilization (8.8%) and outpatient utilization (5.3%) as well.

Although hospital structural variables (# of 100 Beds, Nurses per 100 beds, # of Specialist physician) were not statistically significant in order to determine inpatient and outpatient utilization, hospital teaching status had statistically significant effect on the dependent variables. Teaching hospitals had higher inpatient utilization (13.4%) and outpatient utilization (21.9%). However, hospital type measure by tertiary, large, and small hospital was indifferent and not statistically significant. ICC of utilization measure results showed that 6.01% for inpatient utilization and 4.05% for outpatient utilization.

Table 22. Results of linear mixed models for association of utilization with individual and hospital factors

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	0.035	0.776	0.156	0.397
	70-79	0.250	0.042	0.389	0.035
	60-69	0.315	0.010	0.602	0.001
	50-59	0.340	0.006	0.658	0.000
	40-49	0.248	0.045	0.545	0.003
	30-39	0.153	0.225	0.588	0.002
	20-29	0.091	0.527	0.210	0.324
	-19	Ref.		Ref.	
Sex					
	Male	-0.031	<.0001	0.086	<.0001
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.169	<.0001	0.238	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.453	<.0001	-1.171	<.0001
	During 1-1.99 yrs	0.593	<.0001	-0.164	<.0001
	2-2.99 yrs	0.539	<.0001	0.112	<.0001
	3-3.99 yrs	0.492	<.0001	0.237	<.0001
	4-4.99 yrs	0.360	<.0001	0.168	<.0001
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.114	<.0001	-0.024	0.059
	2006	-0.027	0.003	0.022	0.079
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	0.131	<.0001	0.215	<.0001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	0.194	<.0001	0.015	0.791
	Non-disabled	Ref.		Ref.	
ICU Days		0.022	<.0001	-0.002	0.151
Ventilator Days		-0.002	0.016	-0.001	0.326
Number of Inpatient admissions		0.088	<.0001	0.053	<.0001
Teaching Status					
	Teaching	0.134	0.001	0.219	<.0001
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.034	0.594	0.107	0.146
	Large	-0.072	0.046	0.079	0.101
	Small	Ref.		Ref.	
# of 100 Beds		0.026	0.009	-0.013	0.273
Nurses per 100 beds		0.003	0.846	0.015	0.270
# of Specialist physician		-0.0007	0.087	0.0012	0.004
ICC		6.01%		4.05%	

V. Discussion

1. Discussion of Study Methods

In this study, we examined the association of individual and hospital level factors with healthcare spending and utilization of nationwide 5 years follow-up lung cancer patients using 2002-2012 health insurance claims data. Spending and utilization were measured mainly total, inpatient, and outpatient spending and inpatient LOS and outpatient days as utilization measures. The nationwide dataset over the decade used for the study included all lung cancer patients within the national health insurance program by following up their 60 months period after diagnosis of lung cancer. We used multi-level linear mixed models to compare individual and hospital level factors with spending and utilization of 5 years follow-up lung cancer patients. In order to investigate individual factors associated with survival probability of 5 year follow-up lung cancer patients, cox-proportional hazard model were conducted.

This study has several limitations worth noting, and caution must be taken when interpreting the study's results or attempting to generalize its findings. Although we analyzed all nationwide inpatient claims for lung cancer during a defined period, South Korea's unique health care delivery and insurance system may significantly limit the international generalizability of the results of this study. In addition healthcare spending and utilization of lung cancer care might depend upon the type of health insurance system in place and the ability of healthcare providers to negotiate the price of medical services. In this study, we assumed

spending using nationwide coverage rate of cancer patients, and applied the information into actual national health insurance claim data which might over or underestimate actual spending of nationwide lung cancer patients. Our study also suffered because we don't have non-insurance covered services information, which is one of the most important spending factors. In order to overcome lack of the non-insurance covered services and their spending, we calculated the estimated spending and tried to match with figures of actual spending data.

Also, given the nature of the health insurance claims dataset, this study artificially calculated the diagnosis time of lung cancer patients. Although we used the diagnosis information using the claim data, we are very confident that the diagnosis time in this study properly reflects the actual diagnosis of lung cancer patients because we observed all previous years' claims and excluded first three years of claim information. We assumed that one who diagnosed with lung cancer might have health services utilization at least within 3 years. However, we still suffered from the lack of actual diagnosis date, further research using cohort datasets should be performed to inform the association examined in this study. In order to overcome the identification of lung cancer patients, we also had lists of selection and exclusion criteria to identify actual lung cancer patients. Our final study population was very robust that actual incidence cases reported by national cancer center and cases of our study are very similar (53,364 vs. 53,451), additionally the 5 year survival rate (about 20%).

Furthermore, we investigated only patients with lung cancer. Therefore, our results will differ from those regarding healthcare spending and utilization of

patients with other types of cancer, possibly weakening the reliability of our findings.

A lack of data with which to analyze important aspects of cancer patient was another limitation of our study. For example, we are not able to access to data that matching detailed information of cancer patients reported by national cancer center with health insurance claim data; hence we don't have much clinical information regarding lung cancer patients. Although we included duration of diagnosis to death or end of follow-up in the analytic models, we still have limitation on such information. It would be much better to include in other studies for information of lung cancer stage, site of lung cancer, and type of lung cancer which may influence survival probability, spending and utilization of lung cancer population examined in this study.

In addition, we don't have detailed spending information in the claims data so we don't know how much each patient spent healthcare resources for their cancer treatment which including surgery, chemotherapy, and so on. However, previous study conducted within a tertiary hospital in Korea found evidence that patient who survived more than 5 years spent about $32,000 in their lung cancer treatments[22] which the amount is somewhat greater than our study. We assumed that the spending measure in this study pretty much solid based on the actual measure in the study, however, a study using cohort data should be implemented in order to investigate spending by various time stage of lung cancer patients.

We also could not have information of detailed SES of each of lung cancer patients, for example annual income, education level, and other important variables which might influence treatments and outcomes which measured as

spending and utilization of lung cancer patients. Further studies should be conducted using the dataset that matching national health insurance claim data that including mentioned SES data with national cancer center's cancer registry data or other sets of data contain such information. As noted this study doesn't have SES variables, however, we have proxy measure that health insurance type (health insurance vs. medical aids) which explained differences in healthcare spending and utilization between the groups.

Although we're not able to access actual data on patient's socio-economic status, proxy of the measure might explain that "poorer health with more comorbidity and unhealthy behaviors, no or inadequate preventive health care and management of chronic conditions prior to cancer diagnosis, barriers to receiving treatment and adhering to a treatment regimen such as high cost, inability to navigate the health care system, misinformation about and mistrust of the health care system, lack of a usual source of health care, lack of transportation, lack of time off from work, no treatment or delay in receiving treatment"[67-70] Finally a lack of data with which to analyze other important aspects of lung cancer risk factors which may include smoking status, level of exercise, diet, sodium intake, exposure to virus and environmental situation of each patient etc is also one of limitations in this study. However, most of lung cancer patients are current or former smokers and they have relatively higher risk factors than others.

Finally, we used total, inpatient, outpatient spending and utilization of each lung cancer patient that are relevant for policy research recommendations by examining information of total healthcare resources utilized. Zhao et al., however, suggested use of median cost and it confidence intervals when cost data collection

is incomplete due to study subjects' right censoring issues are present.[77] The methodology has not yet been adopted for health policy decision making, however, further studies are required to use such method when investigating healthcare spending and utilization of right censored data.

Although several limitations of study design are presented, to the best of our knowledge, this is the one of few evaluations of nationwide trend of spending and utilization using nationwide health insurance claim including all lung cancer patients, further individual and hospital level factors that influences nationwide healthcare spending and utilization of lung cancer patients. We also examined factors associated with survival probability of lung cancer patients as well.

We believe our findings will prove useful to health policy makers in South Korea and international readers especially those residing in countries with national health insurance programs based on fee-for-service payments. Our findings also add to mounting evidence of the need to develop a national cancer management strategy that reduce differences in use of healthcare resources and flexible healthcare benefits plan which might helpful to targeted sub population group.

2. Discussion of Study Results

In this study, descriptive results suggest evidences of spending and utilization among 5-years follow-up lung cancer patients that are including;

- Increase in new lung cancer cases by years during 2005-2007
- Increased spending and utilization nationwide during 2005-2007

- Higher proportion of spending & utilization during very first and last stage of lung cancer
- Higher spending and utilization among non-survived population
- No significant improvements of survival time during 2005 to 2007

Increased spending and utilization could be huge economic and social burden of the society as a whole. In the previous research conducted by Park et al. examined that the average cost for treatment of one lung cancer patient for all 5 years was $32,708 which accounted for 44.7% of the per capita income during the same 5-year period suggesting huge economic burden exists among lung cancer patient in this country.[22]

Another argument would be expansion of cancer related policies that lung cancer patients were more likely to use inpatient and outpatient services as coverage expanded, hence overall healthcare spending increased due to higher utilization in lung cancer patients.[18] In Korea, there are no restrictions on using primary, secondary, and tertiary medical institutions, and no penalties for repeated care. Without referrals for inpatient services, more services might be induced to both patients and providers.[75] Escalating healthcare costs might be caused by unnecessary utilization and could be controlled by fixing reimbursement of annual copayments dependent on severity of cancer progression. Since payment is based on FFS in Korea, patients and providers lack incentives to reduce utilization. Government agencies alone can act to gauge national spending levels based on patient's severity, types, and patterns of care, then set reasonable life time copayments limitations.[18] Without the consideration of the proper policy, financial

viability of national health insurance program would be threatened by growing aging population.

In order to prevent escalating health service use, we recommend considering policy changes for government agencies to maintain budget viability for the national health insurance program. First, a copayment flat rate might be the most attractive incentive for patients who make unnecessary outpatient visits and inpatient hospitalizations.[18] This is also a great incentive to providers who are providing excessive unnecessary, expensive, and advanced tech services. The lessons from other studies show that increased cost-sharing decreases health care utilization.[10,19] Different rates of copayments could be applied depending on types of cancer, years of cancer treatment period, cancer stage at diagnosis and costs of various health services. This strategy could help controlling the moral hazard of both patient and providers as well.[18] However, coverage assurance to low-income population should be visible and limitation might not be allowed for such sub-population group. Our study did not examine this income effects, future studies might have better arguments with this issue.

Government agencies also need to focus on more on prevention, not just expanding coverage. Since the landmark reports showing that smoking causes lung cancer over a half century ago,[78] expansion of smoking cessation programs should be first implemented. Furthermore, as our study confirmed, a large portion of healthcare spending occurs in the very end-of-life, so attention should be paid to palliative care, and development and expansion of facilities such as hospices that specialize in end of life care. Previous studies confirmed that hospice care reduces total healthcare costs for the majority of Medicare beneficiaries,[79,80] and

studies conducted in Europe and the United States revealed that the availability of palliative care and hospice programs may help avoid patient hospitalization and reduce costs. It has also been suggested that establishment of palliative care programs is a way to improve the quality of life of terminally ill patients and their families and also to reduce utilization of expensive acute care hospital resources.[81]

Although hospice care was first introduced in 1960s, but the reimbursement system for hospice care from the NHI is not available yet, instead it's reimbursed as normal inpatient care where hospitals don't have incentive to have hospice beds because it requires more resources than ordinary beds.[82] Around 10% of cancer death used hospice care in this country; excess of demand over supply has been presented.[83] Hospice care and palliative care are other areas which could use improvement, because there are an estimated 1 million cancer survivors, which accounted for 1.9% of the entire population in Korea, who have received life-extending cancer treatment.[84] In Korea, hospice care is only available at a limited number of hospitals and with a limited number of hospice beds (hospital N=44, total hospice beds=707). Expansion of hospice bed numbers within hospitals as well as specialized hospice care facilities is required for a financially viable NHI program, as it reduces overall lung cancer burden and provides a greater patient quality of life.

The dataset we used, encompassing data from the last decade of all nationwide lung cancer inpatients as well as the hospitals where they were admitted, contributes to the robustness of our study. The increase in the number of adults living with advanced and complex chronic illnesses and the increase in

expenditures for these patients highlight the need for efficient models, such as palliative care that deliver quality services to complex patient populations.[85]

Regarding the sex factor, difference has found in survival probability (hazard ratio was higher in male) but higher spending and outpatient utilization among male population, although lower inpatient utilization. Regarding the survival probability between male and female, previous research confirmed that the sex differences in tumor etiology may be influenced by physiological factors, such as the role of sex hormones, behavioral and environmental factors, such as levels of sun exposure or smoking habits.[47] Further studies include such factors should be examined in order to find sex differences in this country as well. In the previous health services research literature has repeatedly documented that women utilize more medical care services than men at each point in the life cycle and thus generally have higher costs at each point as well[39] and the cost differentials detected may also provide modest, indirect support for the argument that lung cancer in women is a different disease than it is in men.[47] In this study, we also found evidences of higher spending and utilization among male population.

Regarding the survival probability of deprived SES population, previous studies found evidences that the group had not only significantly lower survival time and lower access to care. Forrest et al. suggested that socioeconomic inequalities in receipt of treatment may exacerbate socioeconomic inequalities in incidence of lung cancer, which is strongly associated with higher smoking rates in more deprived populations, so may further contribute to the poorer outcomes in lower SES groups.[48] Other studies also suggested that lower SES is associated with poorer housing, less social support, and a risk-promoting lifestyle, with a greater

likelihood of smoking.[42] In this study we used medical aids group as proxy of deprived populations, and the study results suggested, however, survival probability of medical aids vs. health insurance was indifferent although spending and utilization were higher in health insurance population. Free access to health insurance covered care might increase survival of medical aids population; however, limited access for un-covered services might induce higher spending and utilization among health insurance population

Demand for private health insurance plans by NHI members, which broadly cover medical expenses caused by catastrophic illness and accidents, is driven by the limited coverage and weak financial protection from the NHI benefit package. Private health insurance plans are both supplementary and complementary to the NHI plan by paying a lump-sum disbursement upon diagnosis of critical illness irrespective of actual medical bills and the receipt of care, or by providing itemized medical expenses compensation upon service use.[86] Since economically vulnerable populations are less likely to have private health insurance to cover their cancer treatment costs, different levels of coverage rate should be implemented based on socio-economic status, especially depending on possession of private insurance among NHI members.[18] In addition, restrictions on inpatient services by medical aids groups or high-tech outpatient services by health insurance holders should be considered as well. Somewhat interestingly, we found less spending and utilization among health insurance population group as compared to medical aids groups for inpatient services. Plausible reason might be NHI members were more likely to utilize relatively fast adoption of state-of-art

technologies under the outpatient basis; medical aids groups were more likely to use inpatient services because all inpatient services were covered.

The results of our study also found evidences associated with lower survival among age with more than 40. As previous research noted that survival of relatively older age groups have lower survivals, we confirmed identical results.[72,73] The results of this study also found that older age groups have higher hazard ratios, the highest hazard ratio was found in age 80+, however, highest spending and utilization was found among 50-59 was presented, although no difference of spending and utilization among age more than age more than 80. Health insurance coverage policies that consider age should be implemented as well in order to maintain financial viability of national health insurance program.

Hospital characteristics especially for teaching status and hospital type rather than specific hospital structural variables (number of beds, physician, and nurse) associated with higher spending and utilization. Teaching hospitals were historically commanded high payment rates more than its counterparts in order to support their cost structure because of their reputations for providing high-quality healthcare, their specialized health service capacity, and education of medical students.[52,53] Higher spending also found in tertiary and large hospitals in this study that they enforce their reputation as well. This study also confirmed the results of the previous research that the teaching hospitals had higher spending and utilization. The present results imply a significant impact of hospital teaching status and hospital types, on the healthcare spending and utilization among nationwide lung cancer patients. As conventional study suggested, large hospitals

may include a greater share of physicians, nurses, allied health professionals and other ancillary costs.[54]

Summary of results in this study is presented in table 23 which contain results presented in this study by individual and hospital level factors of spending and utilization, further survival probability results. In sum, we found concrete results of differences in use of healthcare resources among individual and hospital factors that individual with health insurance, male, 40-79 age group and hospital type with tertiary and large, teaching had higher spending and utilization among nationwide lung cancer patients. The results of this also confirmed previous research that remaining questions regarding the cost-benefit of proven interventions measured by healthcare spending and utilization that rising costs are outpacing inflation rates and each nation's budgetary level[8] since we found evidences of inverse or indifferent survival probability with higher healthcare spending and utilization.

Table 23. Summary of results

	Factors	Spending & Utilization	Survival
Individual	5 Years Survivors*	Lower	Higher
	Diagnosed in year 2007	Higher	Indifferent
	Health Insurance†	Higher	Indifferent
	Male	Higher	Lower
	40+ Older Age Groups‡	Higher	Lower
Hospital	Tertiary/Large Hospital§	Higher	Higher
	Teaching Hospital	Higher	Higher

Note: *Not highest in death within a year of diagnosis, †Lower for inpatient spending and utilization, ‡ Indifferent spending and utilization in age group of 80+, § Indifferent utilization

Finally, this study suggests that efficient manner of healthcare spending and utilization policy should be implemented in order to maintain financial viability of national health insurance program. Finally, healthcare spending and utilization should be targeted to underserved population group that will ensure efficient locus of healthcare service delivery.

VI. Conclusion

Our retrospective cohort design study using nationwide health insurance claims data of past decade showed that increase in new lung cancer cases by years during 2005-2007, increased spending and utilization nationwide during 2005-2007, no significant improvements of survival time, higher proportion of spending and utilization during very first and last stage of lung cancer, and higher spending and utilization among non-survived population.

Using the multivariate analysis methods we found evidences of differences in use of healthcare resources among individual and hospital factors that individual with health insurance, male, 40-79 age group and hospital type with tertiary and large, teaching had higher spending and utilization, although survival of health insurance were indifferent, male and 40+ older age group had relatively lower in their survivals among nationwide 5 years follow-up lung cancer patients.

As inverse relationship between survivals probability with healthcare spending and utilization, this study might suggest that efficient manner of healthcare policy implementation for patients' spending and utilization in order to maintain financial viability of national health insurance program that the allocation of limited health-care resources demands an agreed rational allocation principle, and consequently priority setting is of considerable importance.

Moreover, healthcare spending and utilization considered to be targeted to under-served population groups that will ensure efficient locus of healthcare service delivery by accounting for survival probability of different sub-population group.

Results of this study might be useful to health policy makers not only in South Korea but also international readers that need to develop a national cancer management strategy that reduce differences in healthcare resources and flexible healthcare benefits plan which might helpful to targeted sub population group.

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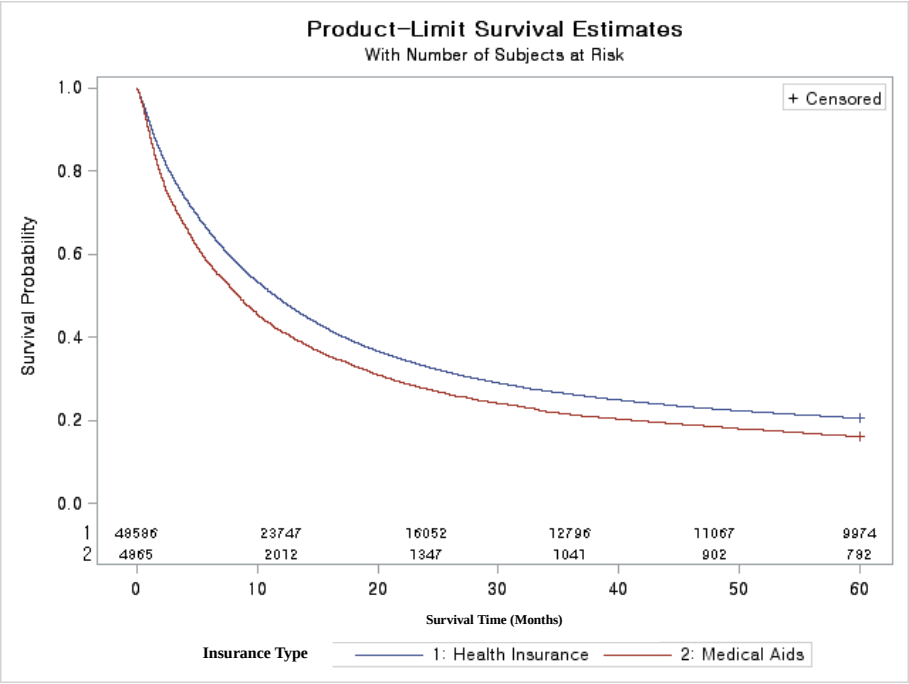
Appendix

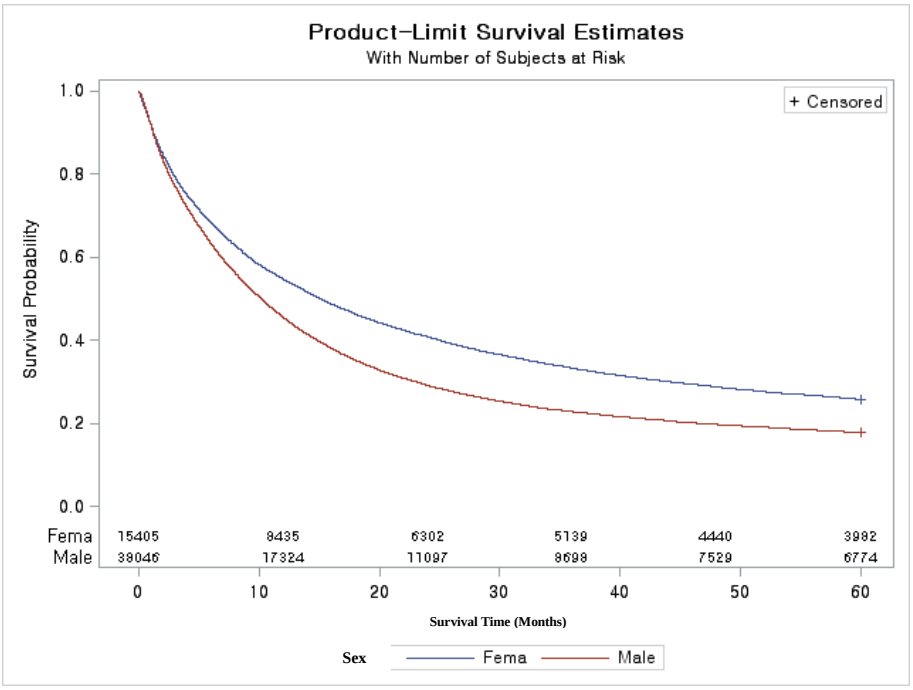
Appendix A. Supplementary figures for Survival Analysis

A-1. Unadjusted Kaplan Meier curves: Association between individual factors and survival among 5 years follow-up lung cancer patients

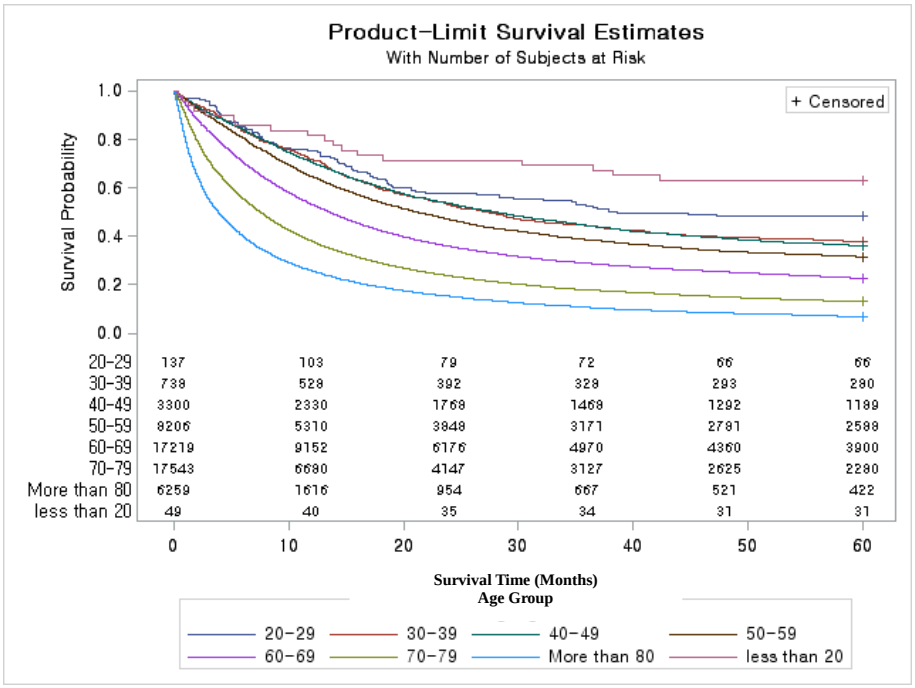
A-1-1. Health Insurance Vs. Medical Aids



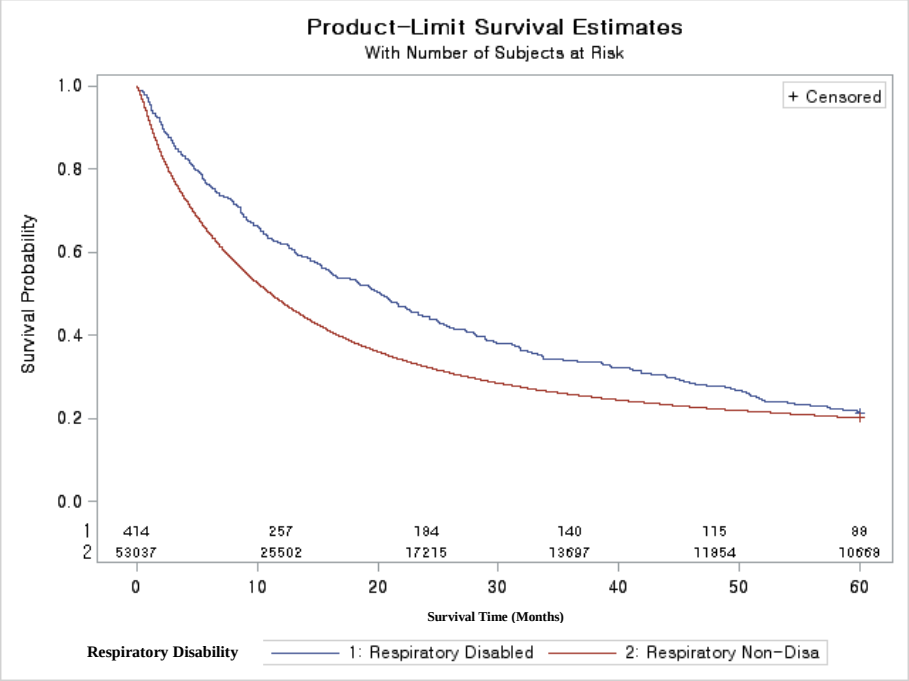
A-1-2. Sex: Male Vs. Female



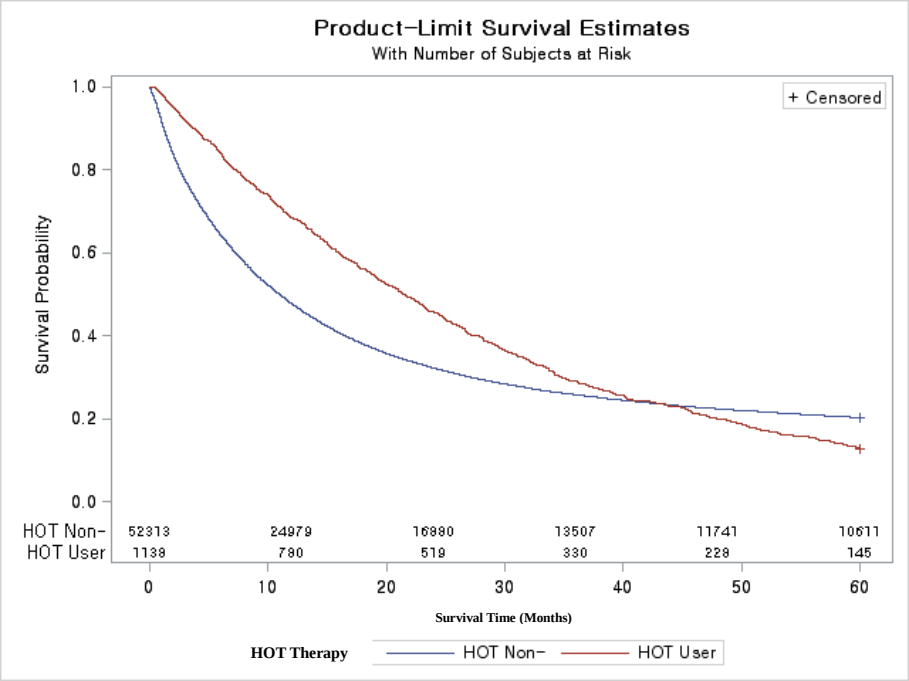
A-1-3. Age group Strata



A-1-4. Respiratory disabled Vs. Respiratory Non-disabled

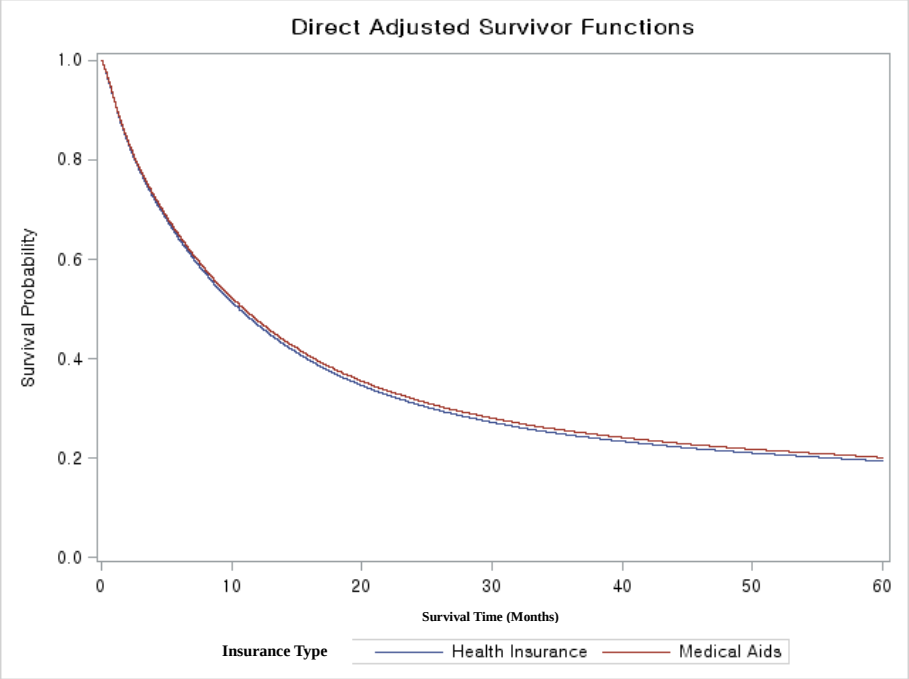


A-1-5. Home-oxygen therapy user Vs. Home-oxygen therapy Non-user

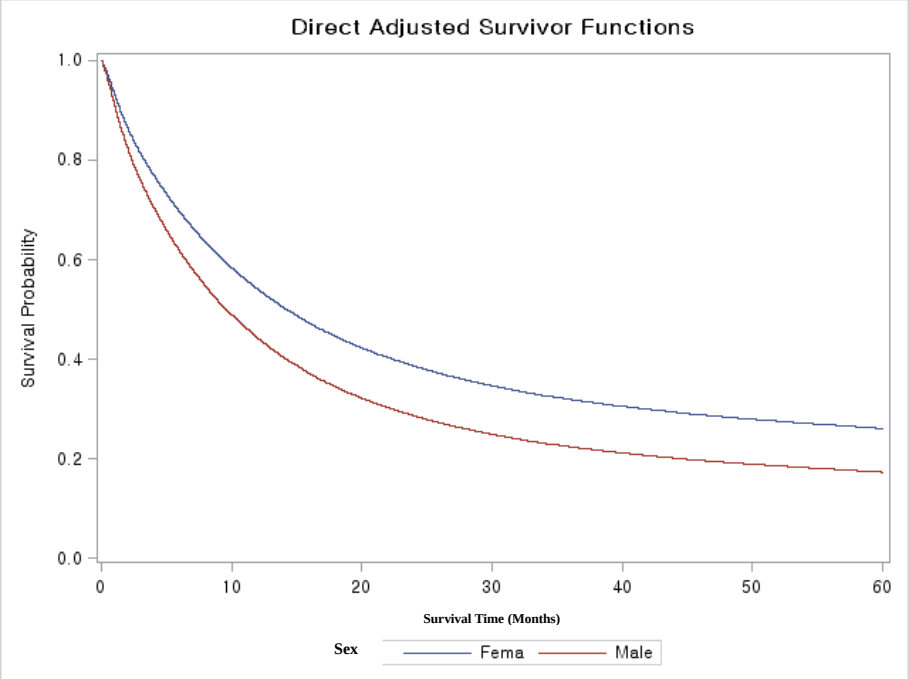


A-2. Adjusted Cox-Proportional Hazard Models: Association between individual factors and survival among 5 years follow-up lung cancer patients

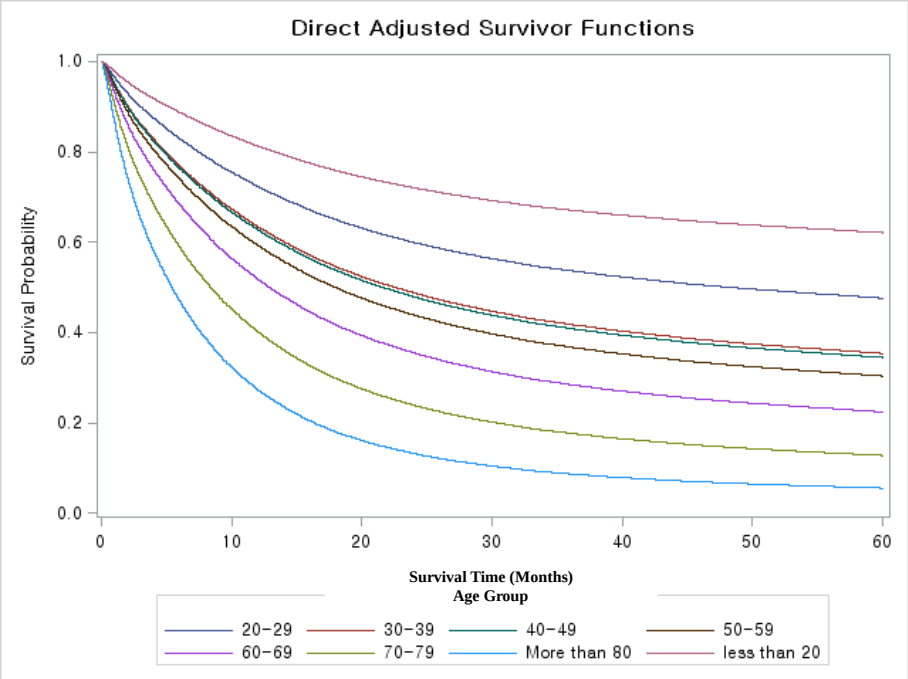
A-2-1. Health Insurance Vs. Medical Aids



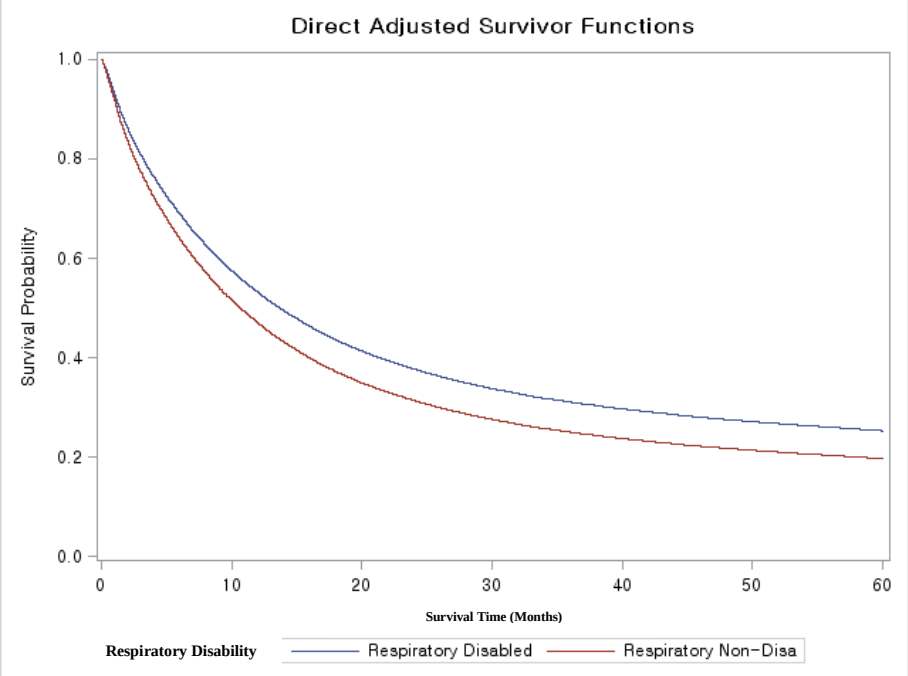
A-2-2. Sex: Male Vs. Female



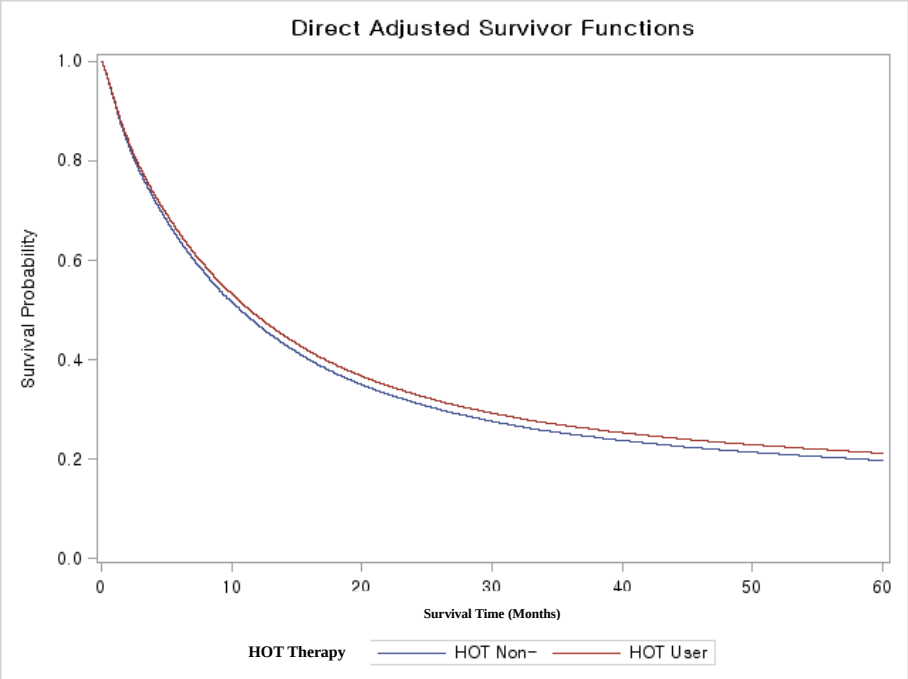
A-2-3. Age group Strata



A-2-4. Respiratory disabled Vs. Respiratory Non-disabled

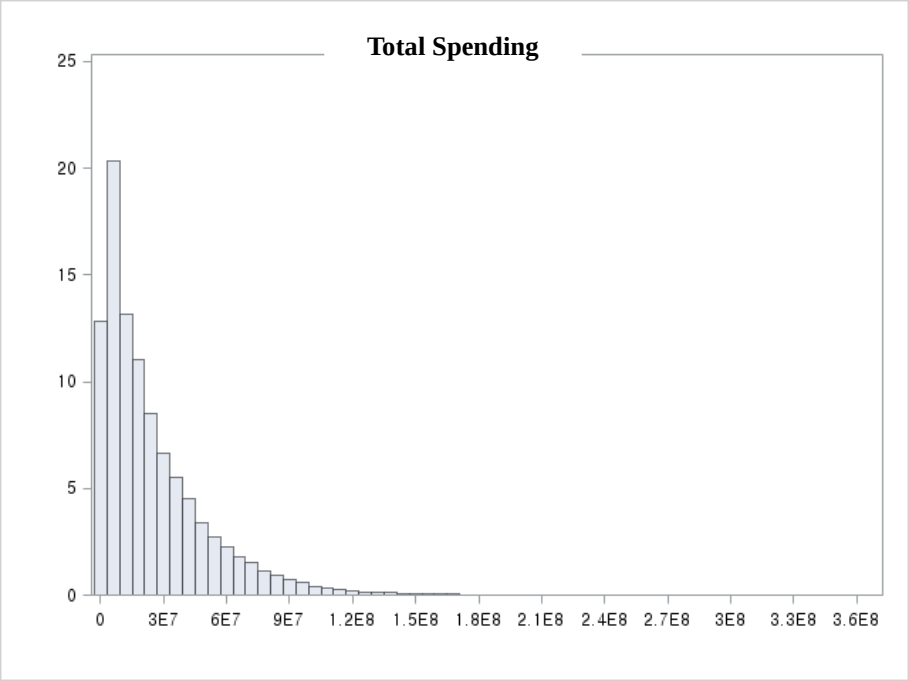


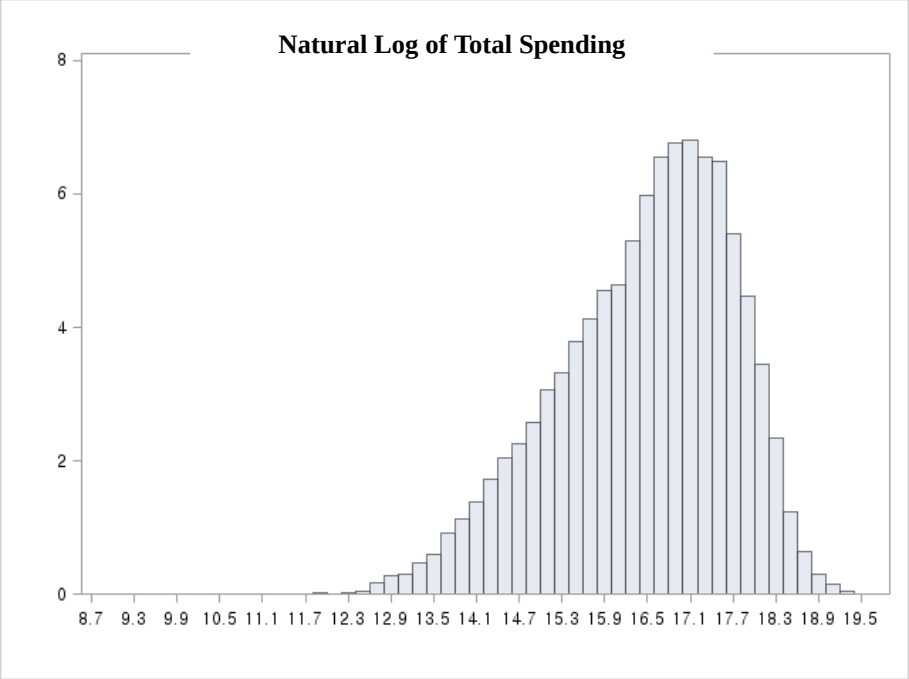
A-2-5. Home-oxygen therapy user Vs. Home-oxygen therapy Non-user



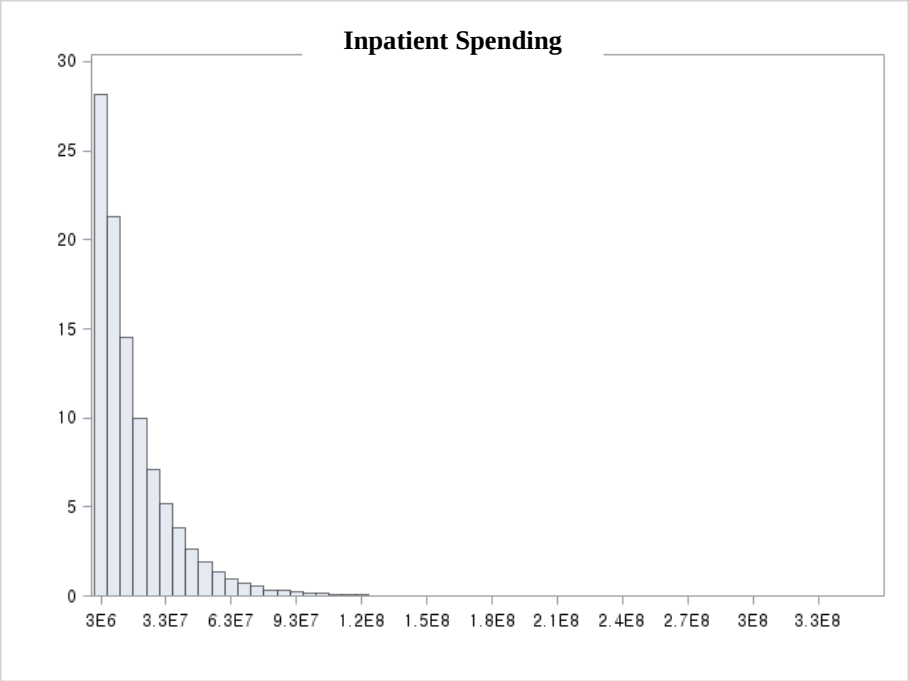
Appendix B. Distribution of Dependent Variables

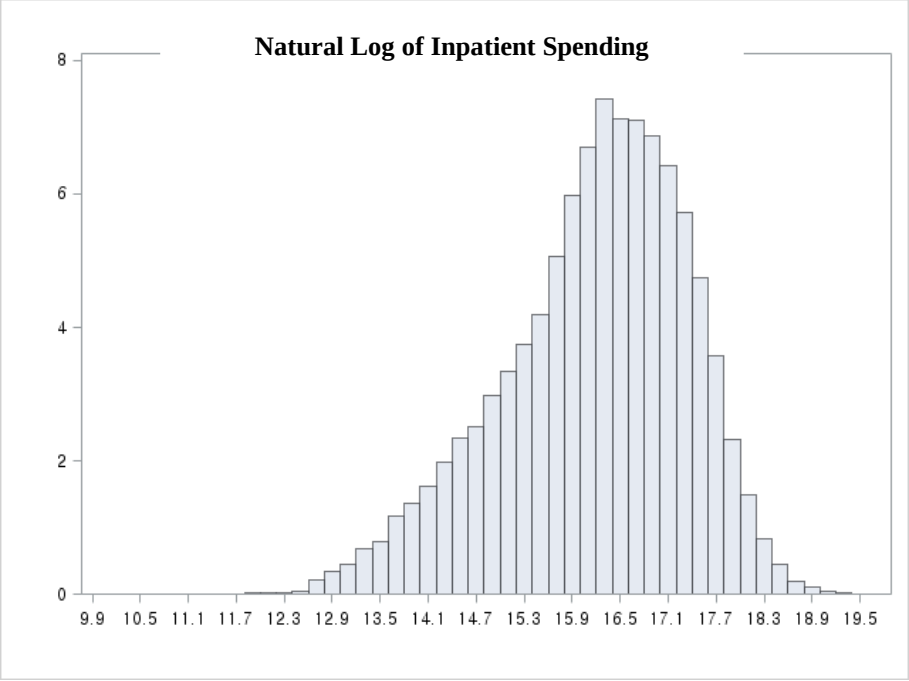
B-1. Total Spending & Natural Log of Total Spending



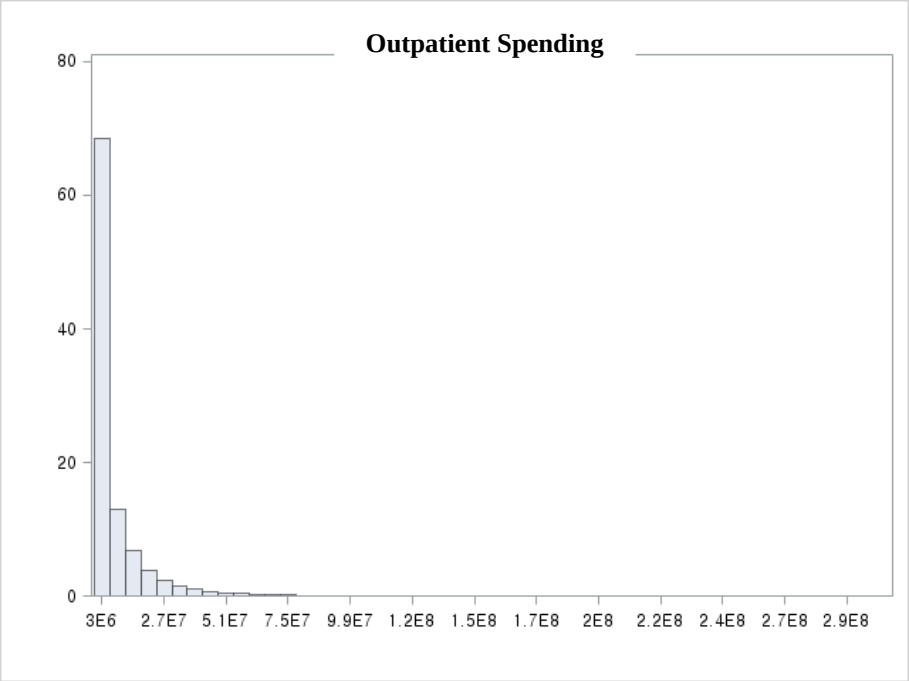


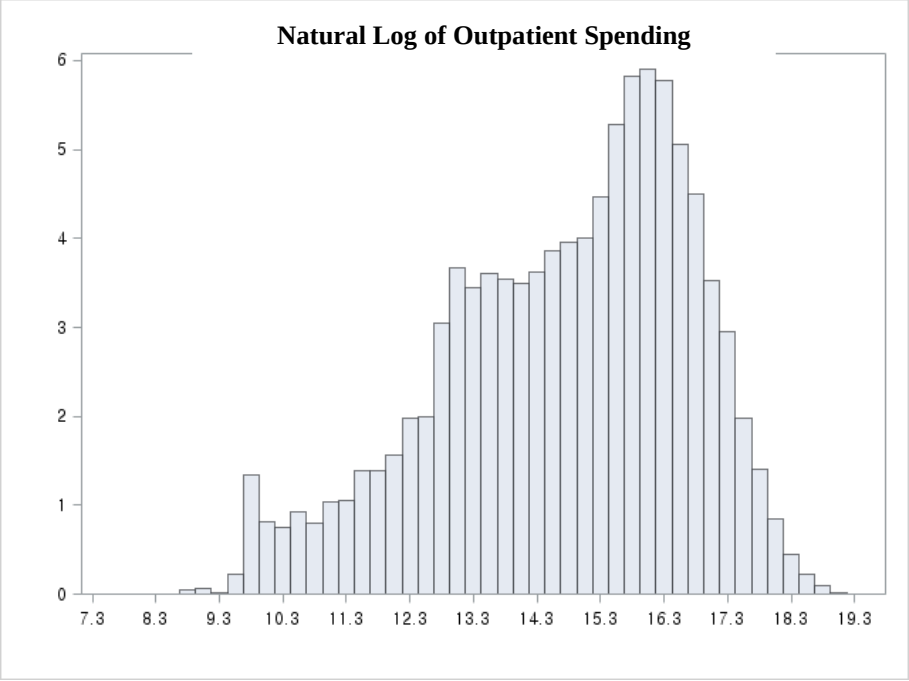
B-2. Inpatient Spending & Natural Log of Inpatient Spending



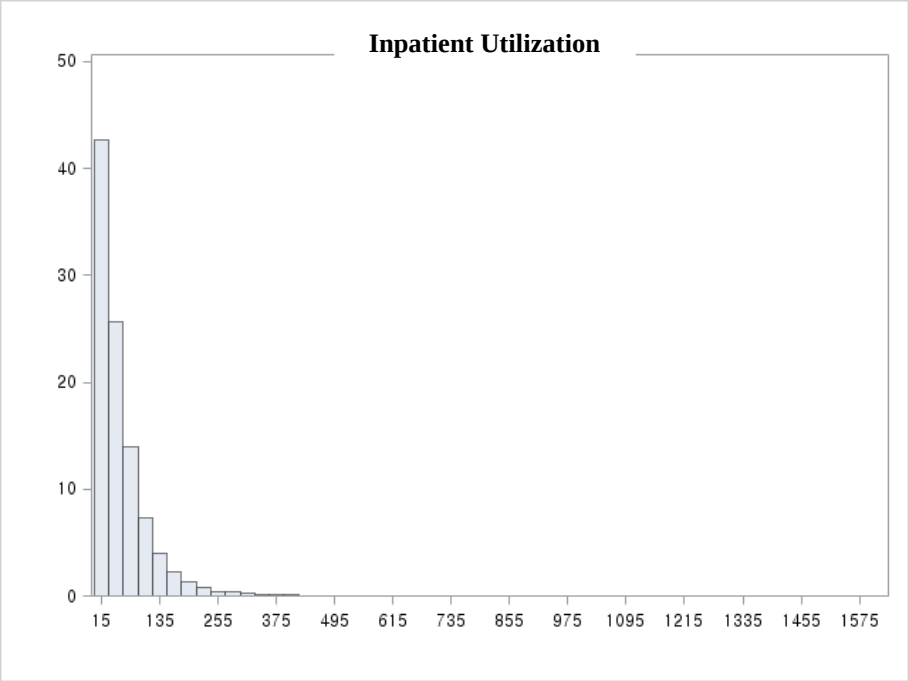


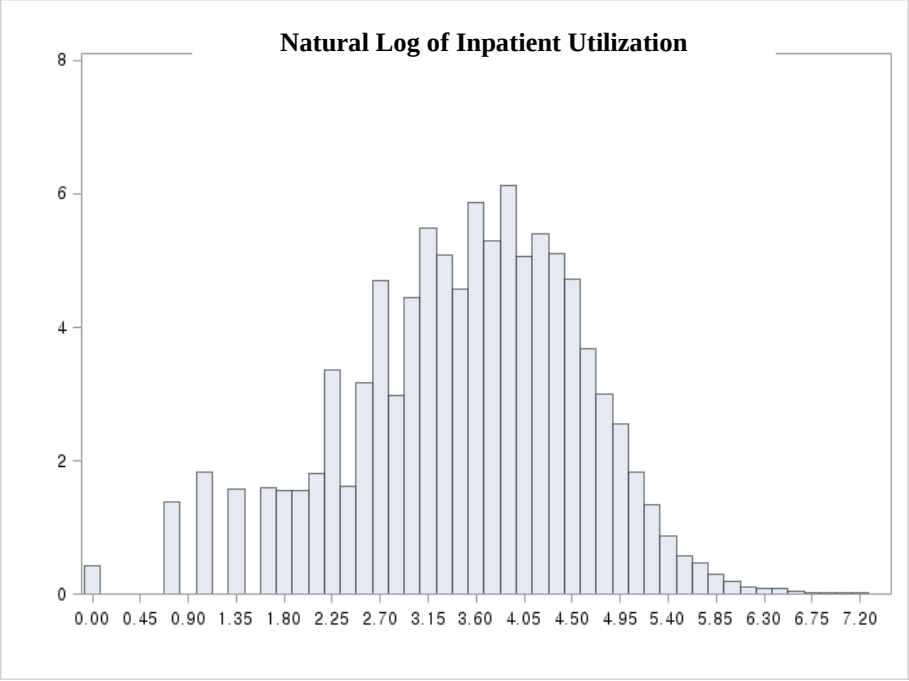
B-3. Outpatient Spending & Natural Log of Outpatient Spending



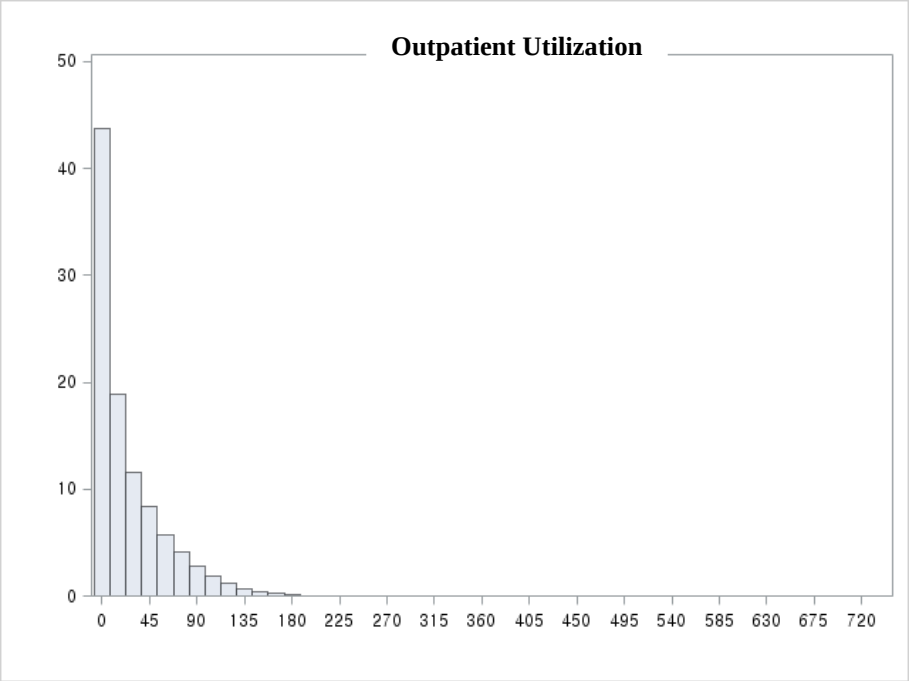


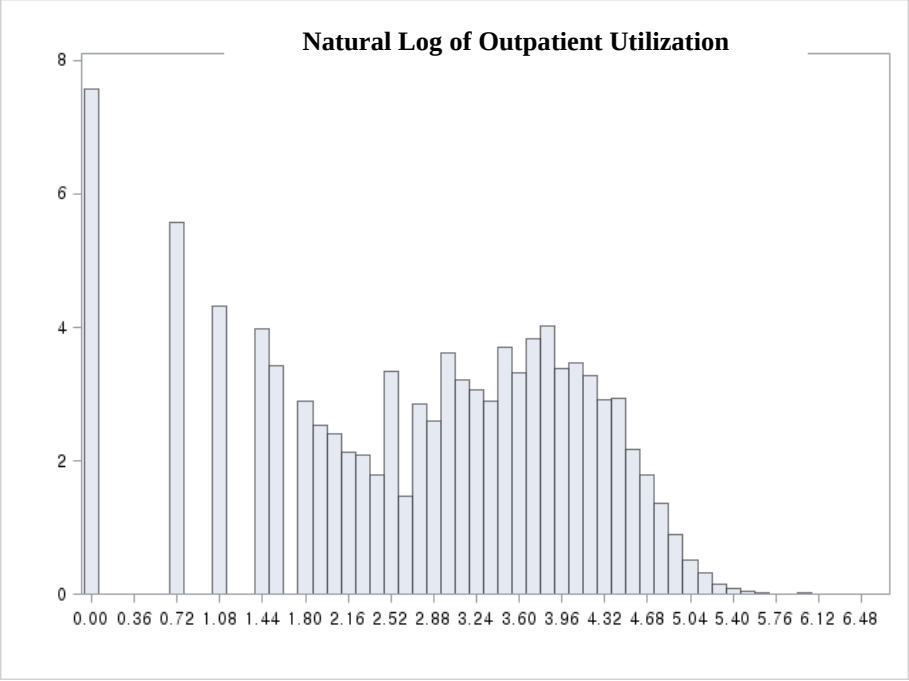
B-4. Inpatient Utilization & Natural Log of Inpatient Utilization





B-5. Outpatient Utilization & Natural Log of Outpatient Utilization





Appendix C. Results of Linear Mixed Models for periods before death

- **C-1. Healthcare spending and utilization of 5 years follow-up lung cancer patients during last 3 months before follow-up end**

- **C-2. Healthcare spending and utilization of 5 years follow-up lung cancer patients during last 6 months before follow-up end**

- **C-3. Healthcare spending and utilization of 5 years follow-up lung cancer patients during last 12 months before follow-up end**

C-1-1. Healthcare spending during last 3 months before follow-up end

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	-0.316	0.360	-0.772	0.005	0.462	0.423
	70-79	-0.069	0.842	-0.623	0.022	0.865	0.133
	60-69	0.127	0.711	-0.447	0.101	1.220	0.034
	50-59	0.275	0.424	-0.315	0.249	1.399	0.015
	40-49	0.346	0.315	-0.284	0.298	1.454	0.012
	30-39	0.420	0.228	-0.249	0.366	1.538	0.008
	20-29	0.053	0.890	-0.145	0.632	1.042	0.093
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	-0.023	0.122	0.021	0.067	0.064	0.002
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.011	0.658	-0.010	0.575	0.347	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	2.777	<.0001	0.613	<.0001	0.888	<.0001
	During 1-1.99 yrs	2.288	<.0001	0.353	<.0001	1.008	<.0001
	2-2.99 yrs	2.131	<.0001	0.325	<.0001	0.835	<.0001
	3-3.99 yrs	2.012	<.0001	0.310	<.0001	0.656	<.0001
	4-4.99 yrs	1.855	<.0001	0.299	<.0001	0.499	<.0001
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.166	<.0001	-0.174	<.0001	-0.145	<.0001
	2006	-0.052	0.001	-0.067	<.0001	-0.047	0.026
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.205	<.0001	0.006	0.855	0.195	0.000
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.003	0.967	-0.054	0.351	0.021	0.832
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.013	<.0001	0.016	<.0001	-0.012	<.0001
Ventilator Days		0.022	<.0001	0.017	<.0001	0.003	0.225
Number of Inpatient admissions		0.057	<.0001	0.027	<.0001	0.020	<.0001
Teaching Status							
	Teaching	0.156	<.0001	0.249	<.0001	0.315	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.138	0.015	0.253	<.0001	0.059	0.396
	Large	0.084	0.051	0.115	0.002	0.115	0.077
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.012	0.144	0.012	0.170	-0.019	<.0001
Nurses per 100 beds		0.016	0.055	0.013	0.222	0.019	<.0001
# of Specialist physician		-0.0003	0.204	-0.0001	0.663	0.0007	<.0001

C-1-2. Healthcare utilization during last 3 months before follow-up end

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.460	0.100	0.460	0.143
	70-79	-0.346	0.215	0.554	0.077
	60-69	-0.314	0.260	0.654	0.037
	50-59	-0.242	0.386	0.667	0.033
	40-49	-0.232	0.408	0.650	0.038
	30-39	-0.254	0.369	0.706	0.025
	20-29	-0.110	0.723	0.588	0.082
	-19	Ref.		Ref.	
Sex					
	Male	-0.088	<.0001	0.032	0.005
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.137	<.0001	0.171	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.558	<.0001	0.550	<.0001
	During 1-1.99 yrs	0.406	<.0001	0.546	<.0001
	2-2.99 yrs	0.358	<.0001	0.475	<.0001
	3-3.99 yrs	0.315	<.0001	0.354	<.0001
	4-4.99 yrs	0.296	<.0001	0.338	<.0001
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.118	<.0001	0.026	0.027
	2006	-0.027	0.029	0.020	0.089
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	-0.0003	0.993	0.153	<.0001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.081	0.169	0.030	0.583
	Non-disabled	Ref.		Ref.	
ICU Days		0.015	<.0001	-0.006	<.0001
Ventilator Days		0.003	0.010	-0.001	0.525
Number of Inpatient admissions		0.033	<.0001	0.014	<.0001
Teaching Status					
	Teaching	0.060	0.035	0.066	0.038
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.035	0.286	0.007	0.854
	Large	-0.060	0.062	0.055	0.119
	Small	Ref.		Ref.	
# of 100 Beds		0.018	0.004	-0.015	0.029
Nurses per 100 beds		0.004	0.596	0.004	0.548
# of Specialist physician		-0.0007	0.001	0.0009	<.0001

C-2-1. Healthcare spending during last 6 months before follow-up end

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	0.042	0.871	-0.589	0.023	0.312	0.415
	70-79	0.348	0.177	-0.363	0.161	0.778	0.042
	60-69	0.559	0.030	-0.167	0.519	1.212	0.002
	50-59	0.670	0.009	-0.041	0.875	1.389	<.0001
	40-49	0.728	0.005	-0.016	0.951	1.445	<.0001
	30-39	0.761	0.004	0.005	0.984	1.618	<.0001
	20-29	0.619	0.035	0.206	0.473	1.256	0.004
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	-0.048	<.0001	-0.004	0.704	0.043	0.028
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.029	0.170	-0.024	0.166	0.380	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	2.991	<.0001	0.940	<.0001	1.193	<.0001
	During 1-1.99 yrs	2.536	<.0001	0.620	<.0001	1.534	<.0001
	2-2.99 yrs	2.319	<.0001	0.507	<.0001	1.309	<.0001
	3-3.99 yrs	2.116	<.0001	0.429	<.0001	1.004	<.0001
	4-4.99 yrs	1.933	<.0001	0.389	<.0001	0.869	<.0001
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.147	<.0001	-0.179	<.0001	-0.159	<.0001
	2006	-0.049	<.0001	-0.067	<.0001	-0.055	0.006
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.305	<.0001	0.085	0.005	0.255	<.0001
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.097	0.129	-0.055	0.322	0.270	0.004
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.013	<.0001	0.019	<.0001	-0.010	<.0001
Ventilator Days		0.018	<.0001	0.015	<.0001	0.005	0.026
Number of Inpatient admissions		0.075	<.0001	0.047	<.0001	0.045	<.0001
Teaching Status							
	Teaching	0.215	<.0001	0.255	<.0001	0.269	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.207	<.0001	0.259	<.0001	0.081	0.442
	Large	0.109	<.0001	0.155	<.0001	0.004	0.953
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.021	0.021	0.022	0.031	0.009	0.559
Nurses per 100 beds		0.017	0.101	0.014	0.280	0.027	0.119
# of Specialist physician		-0.0004	0.200	-0.0003	0.472	0.0005	0.376

C-2-2. Healthcare utilization during last 6 months before follow-up end

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.462	0.089	0.443	0.055
	70-79	-0.274	0.313	0.621	0.007
	60-69	-0.219	0.421	0.786	0.001
	50-59	-0.145	0.594	0.820	<.0001
	40-49	-0.134	0.623	0.796	0.001
	30-39	-0.159	0.565	0.893	<.0001
	20-29	0.001	0.997	0.765	0.003
	-19	Ref.		Ref.	
Sex					
	Male	-0.112	<.0001	0.035	0.003
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.141	<.0001	0.203	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.850	<.0001	0.753	<.0001
	During 1-1.99 yrs	0.661	<.0001	0.952	<.0001
	2-2.99 yrs	0.543	<.0001	0.826	<.0001
	3-3.99 yrs	0.455	<.0001	0.637	<.0001
	4-4.99 yrs	0.414	<.0001	0.619	<.0001
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.120	<.0001	0.032	0.011
	2006	-0.022	0.070	0.026	0.032
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	0.0692	0.028	0.236	<.0001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.096	0.099	0.052	0.358
	Non-disabled	Ref.		Ref.	
ICU Days		0.017	<.0001	-0.006	<.0001
Ventilator Days		0.002	0.045	0.002	0.250
Number of Inpatient admissions		0.050	<.0001	0.028	<.0001
Teaching Status					
	Teaching	0.093	<.0001	0.201	<.0001
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.058	0.262	0.053	0.358
	Large	-0.083	0.019	0.041	0.336
	Small	Ref.		Ref.	
# of 100 Beds		0.020	<.0001	-0.015	<.0001
Nurses per 100 beds		0.004	0.067	0.002	0.301
# of Specialist physician		-0.0008	<.0001	0.0008	<.0001

C-3-1. Healthcare spending during last 12 months before follow-up end

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	0.304	0.150	-0.316	0.167	0.283	0.421
	70-79	0.639	0.003	-0.047	0.837	0.795	0.024
	60-69	0.861	<.0001	0.162	0.477	1.261	<.0001
	50-59	0.963	<.0001	0.280	0.221	1.451	<.0001
	40-49	0.980	<.0001	0.281	0.219	1.469	<.0001
	30-39	1.019	<.0001	0.277	0.232	1.619	<.0001
	20-29	0.806	0.001	0.301	0.237	1.213	0.002
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	-0.037	0.002	0.010	0.355	0.023	0.217
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.043	0.025	-0.036	0.030	0.411	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	2.776	<.0001	1.198	<.0001	0.908	<.0001
	During 1-1.99 yrs	2.568	<.0001	0.946	<.0001	1.796	<.0001
	2-2.99 yrs	2.280	<.0001	0.691	<.0001	1.580	<.0001
	3-3.99 yrs	2.069	<.0001	0.557	<.0001	1.291	<.0001
	4-4.99 yrs	1.768	<.0001	0.458	<.0001	0.996	<.0001
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.177	<.0001	-0.162	<.0001	-0.230	<.0001
	2006	-0.101	<.0001	-0.065	<.0001	-0.115	<.0001
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.344	<.0001	0.168	<.0001	0.305	<.0001
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	-0.018	0.750	-0.120	0.018	0.286	0.002
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.013	<.0001	0.019	<.0001	-0.007	<.0001
Ventilator Days		0.014	<.0001	0.012	<.0001	0.003	0.077
Number of Inpatient admissions		0.088	<.0001	0.069	<.0001	0.059	<.0001
Teaching Status							
	Teaching	0.283	<.0001	0.279	<.0001	0.301	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.228	<.0001	0.290	<.0001	0.122	0.276
	Large	0.093	0.023	0.154	<.0001	0.022	0.776
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.019	0.065	0.023	0.035	0.006	0.721
Nurses per 100 beds		0.019	0.114	0.016	0.267	0.032	0.111
# of Specialist physician		-0.0001	0.716	-0.0001	0.725	0.0006	0.307

C-3-2. Healthcare utilization during last 12 months before follow-up end

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.224	0.360	0.418	0.062
	70-79	-0.001	0.995	0.614	0.006
	60-69	0.077	0.754	0.803	<.0001
	50-59	0.146	0.549	0.841	<.0001
	40-49	0.129	0.599	0.805	<.0001
	30-39	0.089	0.720	0.875	<.0001
	20-29	0.097	0.721	0.675	0.008
	-19	Ref.		Ref.	
Sex					
	Male	-0.097	<.0001	0.025	0.038
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.145	<.0001	0.192	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	1.081	<.0001	0.602	<.0001
	During 1-1.99 yrs	0.928	<.0001	1.279	<.0001
	2-2.99 yrs	0.706	<.0001	1.056	<.0001
	3-3.99 yrs	0.559	<.0001	0.843	<.0001
	4-4.99 yrs	0.470	<.0001	0.732	<.0001
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.108	<.0001	-0.006	0.650
	2006	-0.015	0.197	-0.004	0.764
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	0.1499	<.0001	0.239	<.0001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.144	0.008	0.063	0.280
	Non-disabled	Ref.		Ref.	
ICU Days		0.018	<.0001	-0.005	<.0001
Ventilator Days		0.002	0.126	0.001	0.564
Number of Inpatient admissions		0.069	<.0001	0.044	<.0001
Teaching Status					
	Teaching	0.134	<.0001	0.158	<.0001
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.024	0.435	0.085	0.190
	Large	-0.062	0.026	0.046	0.243
	Small	Ref.		Ref.	
# of 100 Beds		0.018	<.0001	-0.008	0.396
Nurses per 100 beds		0.002	0.333	0.004	0.747
# of Specialist physician		-0.0007	<.0001	0.0010	0.003

Appendix D. Results of Linear Mixed Models for periods after diagnosis

- **D-1. Healthcare spending and utilization of 5 years follow-up lung cancer patients during first 3 months after diagnosis**

- **D-2. Healthcare spending and utilization of 5 years follow-up lung cancer patients during first 6 months after diagnosis**

- **D-3. Healthcare spending and utilization of 5 years follow-up lung cancer patients during first 12 months after diagnosis**

D-1-1. Healthcare spending during first 3 months after lung cancer diagnosis

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	-0.034	0.832	-0.149	0.262	-0.055	0.848
	70-79	0.218	0.167	0.094	0.476	0.371	0.197
	60-69	0.453	0.004	0.274	0.038	0.696	0.016
	50-59	0.515	0.001	0.304	0.022	0.814	0.005
	40-49	0.455	0.004	0.219	0.098	0.766	0.008
	30-39	0.396	0.015	0.138	0.308	0.831	0.005
	20-29	0.222	0.231	0.058	0.706	0.288	0.380
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	0.077	<.0001	0.076	<.0001	0.177	<.0001
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.243	<.0001	0.005	0.748	0.375	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	0.357	<.0001	0.151	<.0001	0.171	<.0001
	During 1-1.99 yrs	-0.014	0.410	-0.130	<.0001	0.478	<.0001
	2-2.99 yrs	-0.130	<.0001	-0.183	<.0001	0.373	<.0001
	3-3.99 yrs	-0.193	<.0001	-0.197	<.0001	0.347	<.0001
	4-4.99 yrs	-0.402	<.0001	-0.219	<.0001	0.044	0.384
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.278	<.0001	-0.184	<.0001	-0.252	<.0001
	2006	-0.136	<.0001	-0.105	<.0001	-0.056	0.002
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	-0.024	0.460	-0.008	0.778	0.145	0.003
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.070	0.208	-0.106	0.019	0.222	0.009
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.026	<.0001	0.026	<.0001	-0.003	0.164
Ventilator Days		-0.004	<.0001	-0.003	0.002	0.005	0.005
Number of Inpatient admissions		0.045	<.0001	0.037	<.0001	0.028	<.0001
Teaching Status							
	Teaching	0.387	<.0001	0.318	<.0001	0.176	0.018
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.379	<.0001	0.309	<.0001	0.072	0.552
	Large	0.154	0.002	0.132	<.0001	-0.014	0.849
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.007	0.640	0.020	0.073	-0.011	0.562
Nurses per 100 beds		0.038	0.041	0.017	0.260	0.060	0.009
# of Specialist physician		0.0005	0.370	0.0000	0.951	0.0004	0.564

D-1-2. Healthcare utilization during first 3 months after lung cancer diagnosis

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.059	0.654	-0.088	0.615
	70-79	0.116	0.378	0.051	0.771
	60-69	0.199	0.130	0.184	0.293
	50-59	0.207	0.115	0.229	0.192
	40-49	0.125	0.344	0.175	0.320
	30-39	0.010	0.943	0.199	0.267
	20-29	-0.034	0.821	-0.085	0.669
	-19	Ref.		Ref.	
Sex					
	Male	0.011	0.194	0.122	<.0001
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.124	<.0001	0.185	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.306	<.0001	0.005	0.709
	During 1-1.99 yrs	-0.042	0.002	0.201	<.0001
	2-2.99 yrs	-0.121	<.0001	0.130	<.0001
	3-3.99 yrs	-0.135	<.0001	0.109	<.0001
	4-4.99 yrs	-0.183	<.0001	-0.042	0.173
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.093	<.0001	-0.042	<.0001
	2006	-0.029	0.002	0.011	0.318
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	-0.0031	0.908	0.077	0.009
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.223	<.0001	0.045	0.387
	Non-disabled	Ref.		Ref.	
ICU Days		0.020	<.0001	-0.001	0.212
Ventilator Days		-0.004	<.0001	0.001	0.417
Number of Inpatient admissions		0.033	<.0001	0.020	<.0001
Teaching Status					
	Teaching	0.109	0.005	0.089	0.030
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.086	0.185	0.055	0.402
	Large	-0.079	0.034	0.067	0.123
	Small	Ref.		Ref.	
# of 100 Beds		0.026	0.011	-0.016	0.125
Nurses per 100 beds		-0.006	0.628	0.007	0.535
# of Specialist physician		-0.0007	0.065	0.0011	0.002

D-2-1. Healthcare spending during first 6 months after lung cancer diagnosis

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	-0.143	0.336	-0.152	0.240	-0.026	0.927
	70-79	0.149	0.313	0.119	0.358	0.468	0.092
	60-69	0.414	0.005	0.326	0.012	0.866	0.002
	50-59	0.491	0.001	0.368	0.005	0.994	<.0001
	40-49	0.404	0.007	0.265	0.041	0.944	0.001
	30-39	0.334	0.028	0.196	0.139	1.032	0.000
	20-29	0.241	0.165	0.116	0.438	0.589	0.065
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	0.089	<.0001	0.090	<.0001	0.172	<.0001
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.172	<.0001	0.003	0.866	0.385	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	0.493	<.0001	0.288	<.0001	0.080	<.0001
	During 1-1.99 yrs	0.133	<.0001	-0.054	<.0001	0.573	<.0001
	2-2.99 yrs	-0.071	0.001	-0.180	<.0001	0.398	<.0001
	3-3.99 yrs	-0.169	<.0001	-0.237	<.0001	0.320	<.0001
	4-4.99 yrs	-0.423	<.0001	-0.282	<.0001	-0.037	0.464
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.267	<.0001	-0.197	<.0001	-0.275	<.0001
	2006	-0.122	<.0001	-0.097	<.0001	-0.072	<.0001
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.014	0.660	-0.023	0.393	0.179	<.0001
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.085	0.103	-0.091	0.045	0.260	0.002
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.028	<.0001	0.029	<.0001	-0.003	0.048
Ventilator Days		-0.004	<.0001	-0.003	0.005	0.004	0.043
Number of Inpatient admissions		0.060	<.0001	0.054	<.0001	0.044	<.0001
Teaching Status							
	Teaching	0.392	<.0001	0.333	<.0001	0.263	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.325	<.0001	0.335	<.0001	0.127	0.280
	Large	0.119	0.013	0.133	<.0001	0.006	0.931
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.011	0.425	0.021	0.072	-0.007	0.727
Nurses per 100 beds		0.040	0.035	0.019	0.214	0.056	0.013
# of Specialist physician		0.0004	0.487	0.0000	0.919	0.0006	0.385

D-2-2. Healthcare utilization during first 6 months after lung cancer diagnosis

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.099	0.448	0.054	0.765
	70-79	0.104	0.426	0.248	0.170
	60-69	0.205	0.116	0.437	0.016
	50-59	0.223	0.088	0.484	0.008
	40-49	0.115	0.380	0.414	0.023
	30-39	0.014	0.915	0.438	0.018
	20-29	-0.029	0.850	0.217	0.297
	-19	Ref.		Ref.	
Sex					
	Male	0.019	0.031	0.126	<.0001
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.134	<.0001	0.203	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.469	<.0001	-0.076	<.0001
	During 1-1.99 yrs	0.026	0.053	0.280	<.0001
	2-2.99 yrs	-0.133	<.0001	0.160	<.0001
	3-3.99 yrs	-0.193	<.0001	0.107	<.0001
	4-4.99 yrs	-0.256	<.0001	-0.096	0.004
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.112	<.0001	-0.049	<.0001
	2006	-0.029	0.002	0.006	0.637
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	-0.0060	0.824	0.105	0.001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.207	<.0001	0.087	0.114
	Non-disabled	Ref.		Ref.	
ICU Days		0.022	<.0001	-0.002	0.086
Ventilator Days		-0.005	<.0001	0.000	0.935
Number of Inpatient admissions		0.050	<.0001	0.033	<.0001
Teaching Status					
	Teaching	0.129	0.001	0.158	<.0001
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.054	0.411	0.075	0.286
	Large	-0.085	0.025	0.060	0.197
	Small	Ref.		Ref.	
# of 100 Beds		0.027	0.008	-0.014	0.213
Nurses per 100 beds		-0.002	0.902	0.012	0.359
# of Specialist physician		-0.0007	0.065	0.0011	0.003

D-3-1. Healthcare spending during first 12 months after lung cancer diagnosis

		Log of Total Spending	P	Log of Inpatient Spending	P	Log of Outpatient Spending	P
Age Group							
	80-	-0.213	0.124	-0.214	0.091	-0.107	0.694
	70-79	0.111	0.419	0.076	0.546	0.417	0.124
	60-69	0.375	0.007	0.291	0.021	0.844	0.002
	50-59	0.472	0.001	0.340	0.007	1.008	<.0001
	40-49	0.391	0.005	0.244	0.054	0.949	0.001
	30-39	0.307	0.031	0.171	0.188	1.055	0.000
	20-29	0.154	0.341	0.042	0.775	0.550	0.080
	-19	Ref.		Ref.		Ref.	
Sex							
	Male	0.087	<.0001	0.088	<.0001	0.156	<.0001
	Female	Ref.		Ref.		Ref.	
Insurance Type							
	Health Insurance	0.102	<.0001	-0.012	0.408	0.404	<.0001
	Medical Aids	Ref.		Ref.		Ref.	
Death After Diagnosis							
	Within a year	0.538	<.0001	0.398	<.0001	-0.187	<.0001
	During 1-1.99 yrs	0.490	<.0001	0.192	<.0001	0.819	<.0001
	2-2.99 yrs	0.081	<.0001	-0.143	<.0001	0.515	<.0001
	3-3.99 yrs	-0.095	<.0001	-0.262	<.0001	0.348	<.0001
	4-4.99 yrs	-0.413	<.0001	-0.360	<.0001	-0.082	0.102
	5 yrs Survivors	Ref.		Ref.		Ref.	
Diagnosed Year							
	2005	-0.255	<.0001	-0.196	<.0001	-0.279	<.0001
	2006	-0.115	<.0001	-0.088	<.0001	-0.074	<.0001
	2007	Ref.		Ref.		Ref.	
Home-Oxygen Therapy							
	User	0.074	0.011	0.007	0.776	0.219	<.0001
	Non-User	Ref.		Ref.		Ref.	
Respiratory Disability							
	Disabled	0.058	0.227	-0.089	0.043	0.271	0.001
	Non-disabled	Ref.		Ref.		Ref.	
ICU Days		0.029	<.0001	0.030	<.0001	-0.003	0.054
Ventilator Days		-0.004	<.0001	-0.002	0.020	0.002	0.388
Number of Inpatient admissions		0.070	<.0001	0.068	<.0001	0.058	<.0001
Teaching Status							
	Teaching	0.375	<.0001	0.343	<.0001	0.315	<.0001
	Non-Teaching	Ref.		Ref.		Ref.	
Hospital Type							
	Tertiary	0.297	<.0001	0.339	<.0001	0.123	0.300
	Large	0.105	0.019	0.127	0.002	-0.011	0.879
	Small	Ref.		Ref.		Ref.	
# of 100 Beds		0.012	0.380	0.023	0.051	-0.001	0.945
Nurses per 100 beds		0.038	0.031	0.019	0.213	0.052	0.022
# of Specialist physician		0.0004	0.478	0.0001	0.910	0.0006	0.341

D-4-2. Healthcare utilization during first 12 months after lung cancer diagnosis

		Log of Inpatient LOS	P	Log of Outpatient Days	P
Age Group					
	80-	-0.142	0.274	-0.016	0.930
	70-79	0.086	0.509	0.218	0.243
	60-69	0.185	0.153	0.446	0.017
	50-59	0.211	0.105	0.513	0.006
	40-49	0.111	0.396	0.428	0.022
	30-39	0.008	0.953	0.454	0.018
	20-29	-0.098	0.517	0.205	0.342
	-19	Ref.		Ref.	
Sex					
	Male	0.015	0.101	0.119	<.0001
	Female	Ref.		Ref.	
Insurance Type					
	Health Insurance	-0.152	<.0001	0.235	<.0001
	Medical Aids	Ref.		Ref.	
Death After Diagnosis					
	Within a year	0.604	<.0001	-0.322	<.0001
	During 1-1.99 yrs	0.314	<.0001	0.478	<.0001
	2-2.99 yrs	-0.104	<.0001	0.268	<.0001
	3-3.99 yrs	-0.218	<.0001	0.144	<.0001
	4-4.99 yrs	-0.339	<.0001	-0.097	0.005
	5 yrs Survivors	Ref.		Ref.	
Diagnosed Year					
	2005	-0.112	<.0001	-0.033	0.008
	2006	-0.025	0.008	0.017	0.153
	2007	Ref.		Ref.	
Home-Oxygen Therapy					
	User	0.0253	0.348	0.159	<.0001
	Non-User	Ref.		Ref.	
Respiratory Disability					
	Disabled	-0.207	<.0001	0.038	0.502
	Non-disabled	Ref.		Ref.	
ICU Days		0.023	<.0001	-0.002	0.205
Ventilator Days		-0.005	<.0001	-0.001	0.417
Number of Inpatient admissions		0.066	<.0001	0.040	<.0001
Teaching Status					
	Teaching	0.143	<.0001	0.325	<.0001
	Non-Teaching	Ref.		Ref.	
Hospital Type					
	Tertiary	-0.038	0.548	0.069	0.331
	Large	-0.088	0.018	0.041	0.387
	Small	Ref.		Ref.	
# of 100 Beds		0.029	0.004	-0.021	<.0001
Nurses per 100 beds		-0.001	0.924	0.010	<.0001
# of Specialist physician		-0.0007	0.074	0.0010	<.0001

Korean Abstract

2002-2012년 국민건강보험 청구자료를 이용한 폐암환자의 의료비 및 의료이용

김선정

서 론: 국내 폐암환자의 수는 지난 수십년간 꾸준히 증가하고 있으며, 폐암은 암 관련 사망자 중 가장 큰 비중을 차지하고 있다. 또한 폐암환자로 인한 의료비 및 의료이용 또한 증가하고 있는 추세이다. 국내의 폐암의 발병, 유병, 사망등과 관련된 연구는 비교적 활발하게 이루진 반면 폐암환자의 의료비 및 의료이용과 관련하여 전체기간별, 추적완료 전 기간, 폐암 진단 후 기간 등 다면적 분석을 시행한 연구는 부족한 현실이다. 또한 의료비와 의료이용의 차이를 설명 할 수 있는 개인 및 병원 요인에 대한 국내 연구 또한 부족한 현실이다. 따라서, 이 연구의 목적은 환자, 병원의 요인이 폐암환자의 의료비 및 의료이용에 미치는 영향을 파악하는 것이다.

자료 및 방법: 이 연구는 2002 년부터 2012 년까지의 전국민 폐암환자 국민건강보험 청구자료를 바탕으로 이루어졌다. 해당기간 동안 총 1,417,380 건의 청구건수가 있었으며, 그 중 673,122 건의 입원청구와 744,258 건의 외래건수가 발생하였다. 해당자료를 바탕으로 이 연구는 청구자료를 환자 개인단위의 후향성 코호트 디자인으로 전환하였다. 새로운 폐암 진단 환자의 포함과 환자선택의 오류를 줄이기 위하여 2005 년 이후의 진단된 환자, 5 년 관찰추적을 마친 환자, 입원진료비 40 만원 이상 사용 환자를 대상으로 하였다. 해당자료를 바탕으로 다양한 의료비 및 의료이용에 대한 측정을 하였다 (전체의료비, 입원/외래 의료비, 추적완료 전 3,6,12 개월, 진단 후 3,6,12 개월 등). 새롭게 생성된 데이터를 바탕으로 각 환자의 생존기간 또한 측정하였다. 최종 데이터는 5 년 관찰 추적한 53,451 명의 폐암환자에 대한 자료를 수집 및 분석을 하였으며 이에 상응하는 916 개 병원의 자료를 매칭하였다. 전국민 폐암환자의 생존분석을 위하여 콕스비례위험모형 (Cox-proportional hazard model)을 사용하였고, 폐암환자의 의료비 및 의료이용에 영향을 미치는 환자 및 병원을 파악하기 위하여 선형혼합모형 (linear mixed model)을 사용하였다.

결 과: 2002 년에서 2012 년 전국민 건강보험 청구자료를 바탕으로 5 년 추적환자, 후향성 코호트 디자인 연구의 분석결과, 해당기간 중 국가 단위 폐암환자의 증가 (2005 년 16,654 명, 2006 년 18,149 명, 2007 년 18,648 명), 의료비 및 의료이용의 증가가 있었으며 (전체의료비 22,883,645 원 ~27,462,222 원; 입원재원일수 51.4 일~58.8 일; 외래이용일수 25.4 일~26.1 일), 추적기간 종료 전, 진단 후 짧은 기간동안 많은 의료비 및 의료이용이 있었음을 확인하였다 (전체 대비 70% 수준의 의료비 및 의료이용, 1 년 기준). 콕스비례위험모형을 바탕으로 한 생존분석 결과 보험형태에 따른 위험비의 차이는 확인 할 수 없었으나 (HR=0.99, P=0.489), 남자 (여자 vs. 남자, HR=0.74, P<0.001), 40 세 이상 연령이 높은 군에서의 위험비가 높은 것은 확인 할 수 있었다 (HR 2.02~6.63, P<0.001). 선형혼합모형을 바탕으로 한 폐암환자의 의료비 및 의료이용에 미치는 환자 및 병원의 요인을 분석한 결과, 건강보험(전체 의료비 2.9% 증가, P<0.001; 외래이용 23.8% 증가, P<0.001), 남자(전체 의료비 5.6% 증가, P<0.001; 외래이용 8.6% 증가, P<0.001), 40-79 세 연령군 (전체 의료비 28.0%~61.0% 증가, P<0.001; 입원일수 24.8% to 34.0% 증가, P<0.001; 외래이용 38.9%~65.8%, P<0.001) 및 상급종합 및 종합병원 (전체 의료비 27.6%, 12.7% 증가, 수련병원 (전체 의료비 35.6% 증가, P<0.001; 입원일수 13.4% 증가, P=0.001; 외래이용 21.9% 증가, P<0.001) 에서의 의료자원 이용의 차이를 확인 할 수 있었다. 일부 인구집단에서는 의료비 및 의료이용과 생존기간의 반비례 현상도 확인 할 수 있었다.

고찰 및 결론: 이 연구는 개인 수준의 건강보험 청구자료 및 병원 특성 자료를 바탕으로 전 국민 폐암환자의 의료비 및 의료이용의 추세와 이에 영향을 미치는 요인을 파악하였다. 이 연구의 결과는 국가 의료체계의 장기적인 성과제고 및 효율적 보험재정 관리를 위한 정책 수립의 근거 자료를 제시 하였다. 또한 이 연구는 폐암환자의 의료비 및 의료이용은 생존기간을 고려하였으며, 일부 의료자원 이용의 차이가 확인된 인구집단에 대한 관리의 필요성을 제기하고 있다. 마지막으로 이 연구의 결과는 비단 대한민국뿐 아니라 의료자원 이용의 차이의 극복과 효율적 의료자원 지원을 포괄하는 국가암관리사업 및 전략이 필요한 기타 국가에게 정책수립의 근거 자료로 활용될 것으로 기대한다.

핵심어: 폐암, 의료비, 의료이용, 생존기간